Validation Plots for TRM QCD prediction

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Two sections are included. In the first section, it is mainly about the old method with the new data. In the second section, methods with new parameters are compared.

1 Old Method

In this section, the original TRM method is applied.

J1(2)Et	25	50	80	100	120	150	200	1000
J1(2)$\|\eta\|$	0.0	0.4	0.8	2.0				
HT3	60	150	350	1000				
J1(2)Z	0.0	0.1	0.2	0.4	0.8	10.		

Table 1: Parameters used in the original version

The calculation of b-tagging rate (note the difference from cdfnote 9275):

$$R_{1S} = \frac{Number\ of\ Single\ Tight\ SecVTX\ tagged\ jets\ falling\ into\ bin\ i}{Number\ of\ Pretag\ jets\ falling\ into\ bin\ i} \tag{1}$$

$$R_{SS} = R_{1S_{J1}} \times R_{1S_{J2}} \tag{2}$$

$$R_{SJ} = \frac{1}{2} \times (R_{1S_{J1}} \times R_{1J_{J2}} + R_{1J_{J1}} \times R_{1S_{J2}}) \tag{3}$$

where,

$$R_{1J} = \frac{Number\ of\ Single\ Tight\ JetProb\ tagged\ jets\ falling\ into\ bin\ i}{Number\ of\ Pretag\ jets\ falling\ into\ bin\ i}$$

The main purpose of this section is to check the original methods with new data. Here, we are using 4 approaches to test the TRM. In the 4^{th} approach, we are using the same parameter but split J1(2)Z into smaller bins due to larger statistics.

1. "old TRM" in 2.1fb^{-1},

2. "old TRM" derived with 2.1fb^{-1} applies to 3.6fb^{-1},

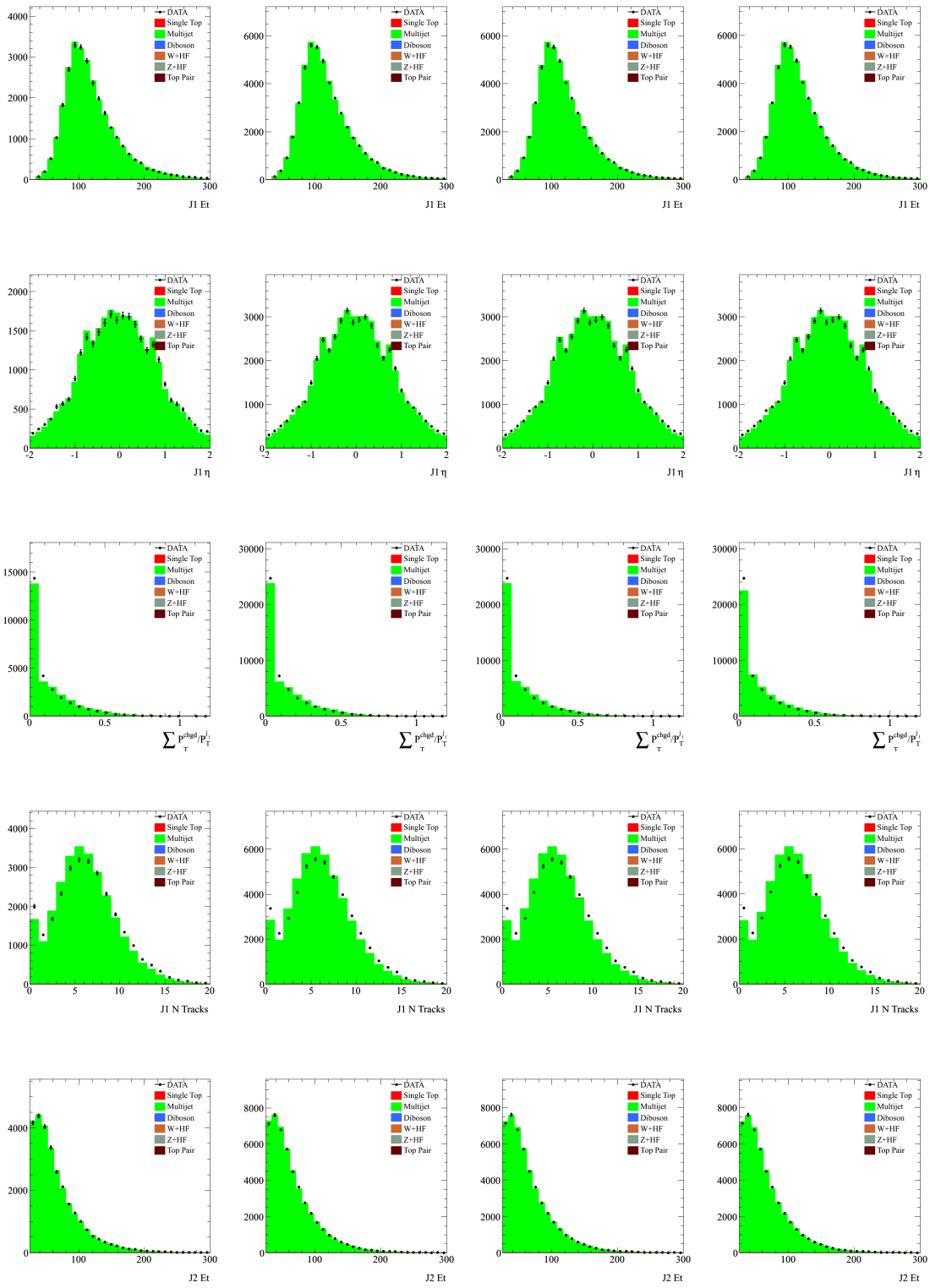
3. "old TRM" but derived with 3.6fb^{-1}, then applies to 3.6fb^{-1},

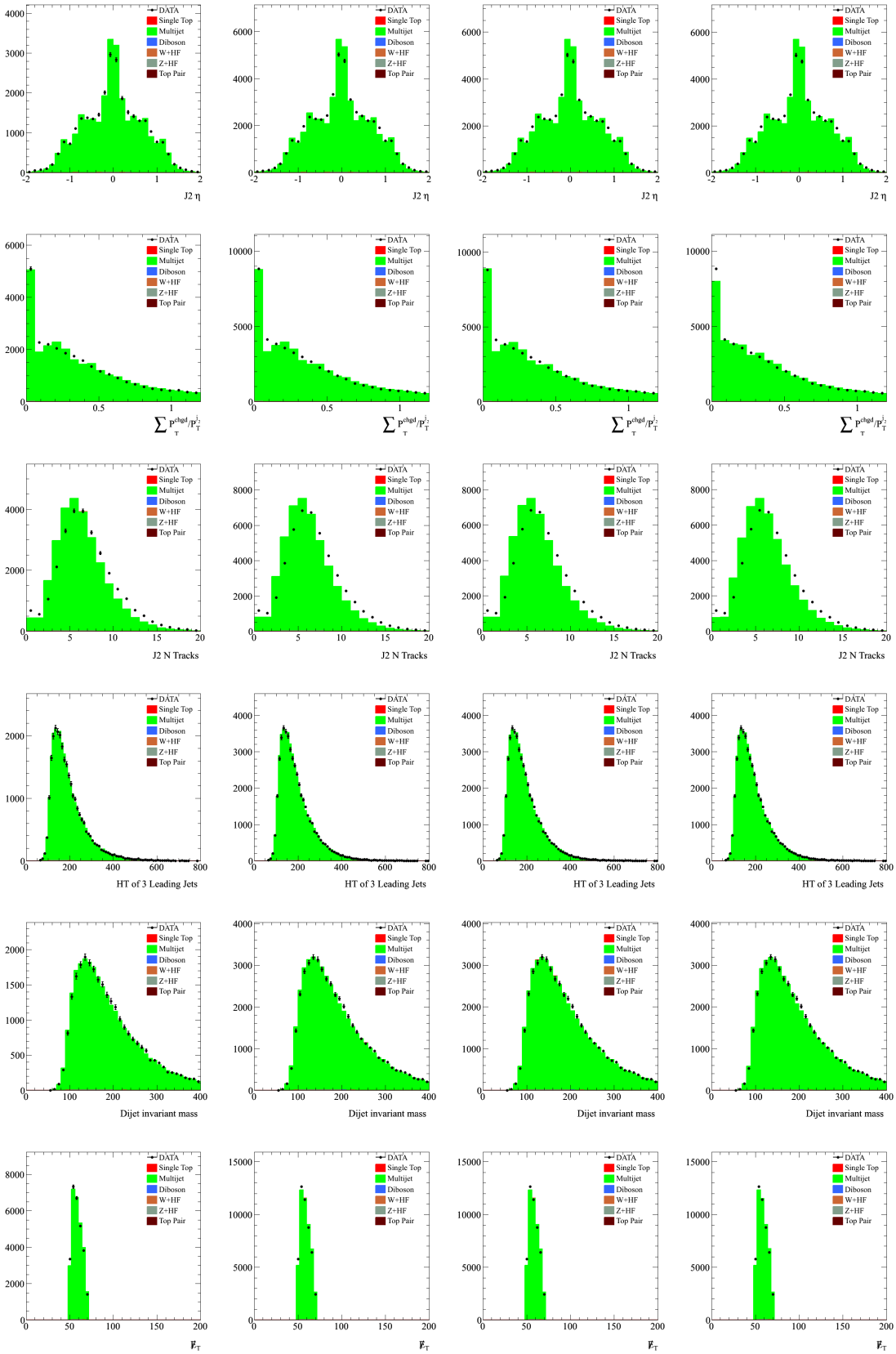
4. "old TRM" but with "smaller bins" in J1(2)Z, derived with 3.6fb^{-1}, then applies to 3.6fb^{-1}.

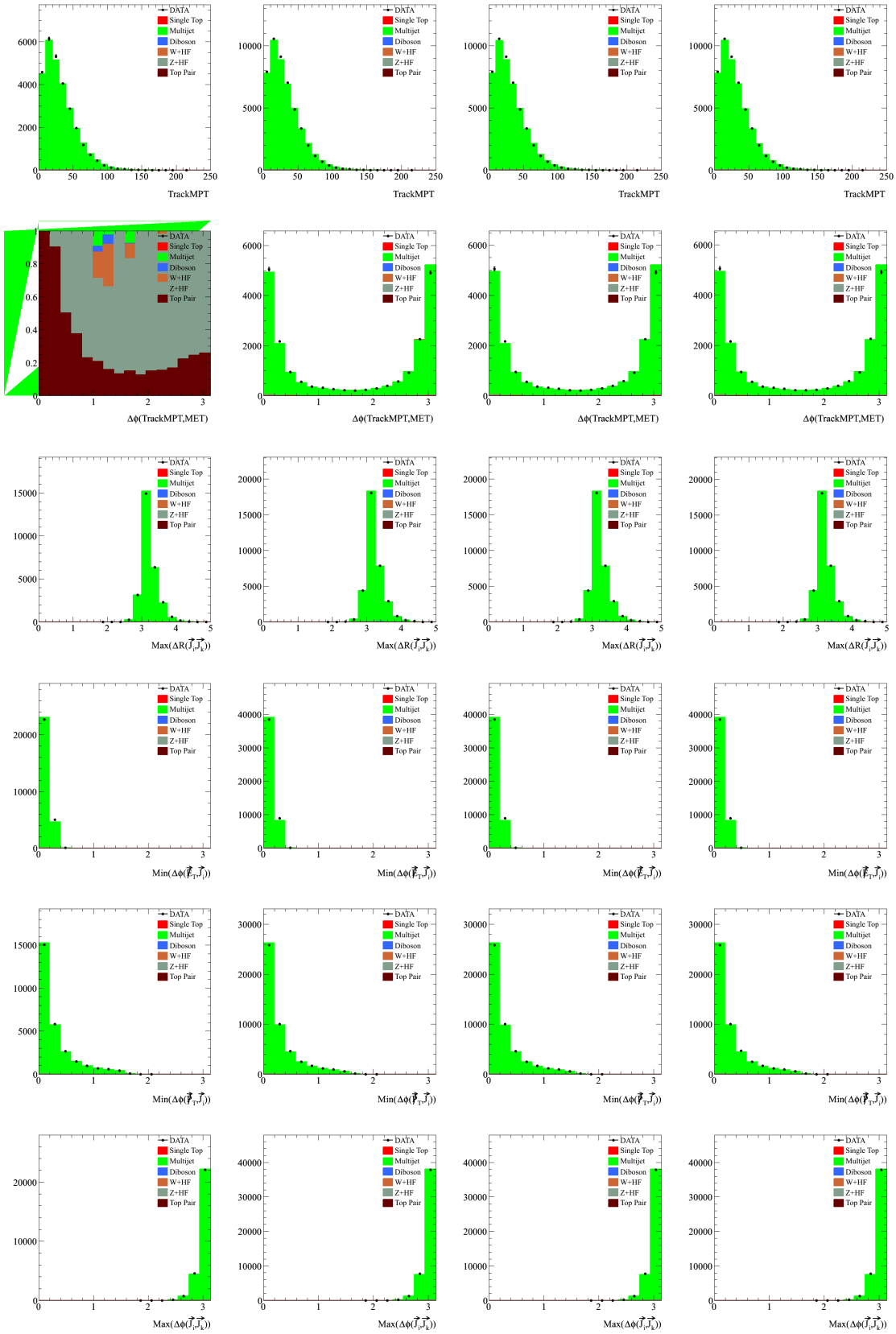
J1(2)Z	0.0	0.05	0.1	0.15	0.2	0.3	0.4	0.6	0.8	10.

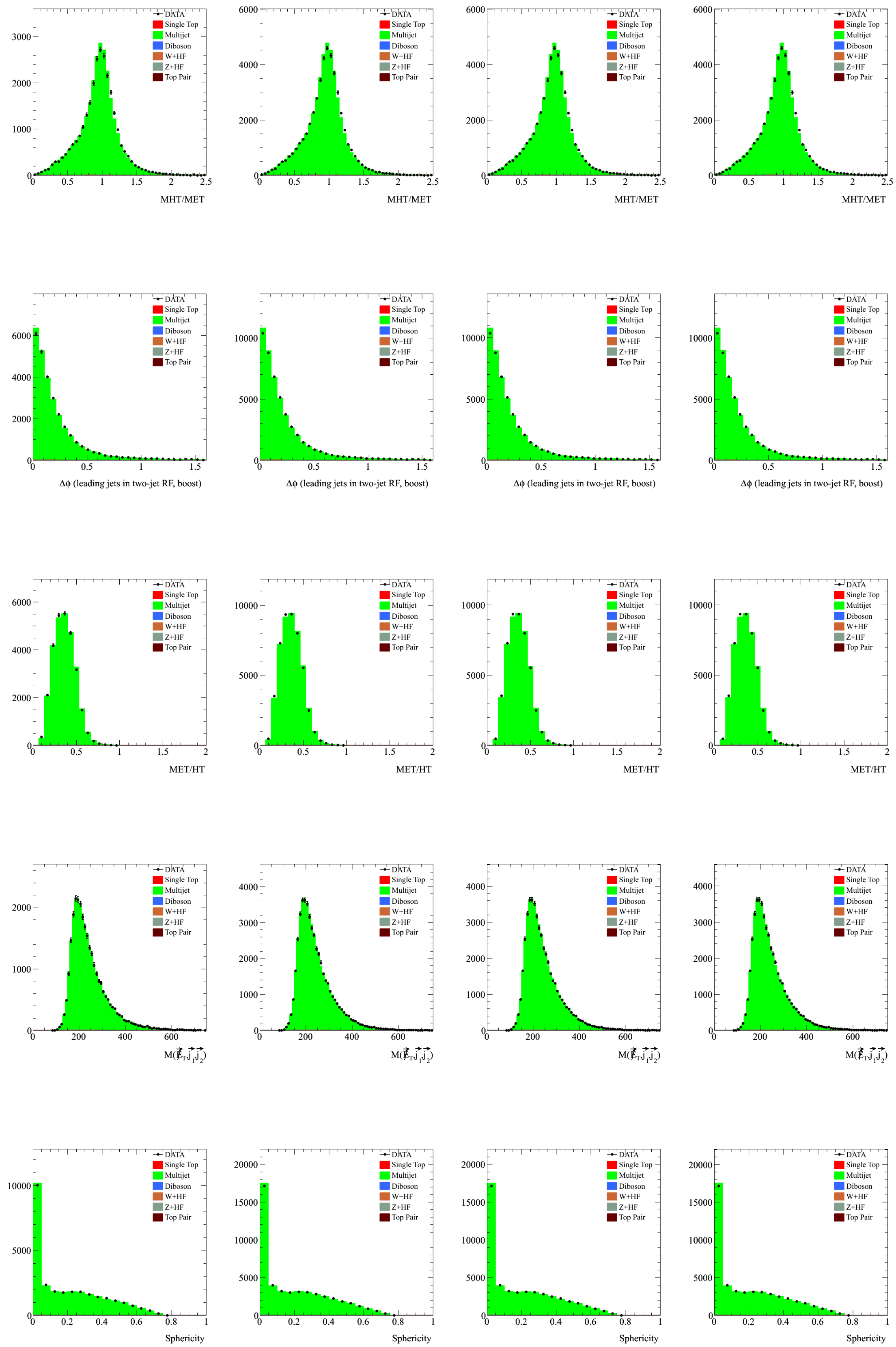
1.1 Category: 1S (in order of 4 approaches)

1.1.1 TRM/ region

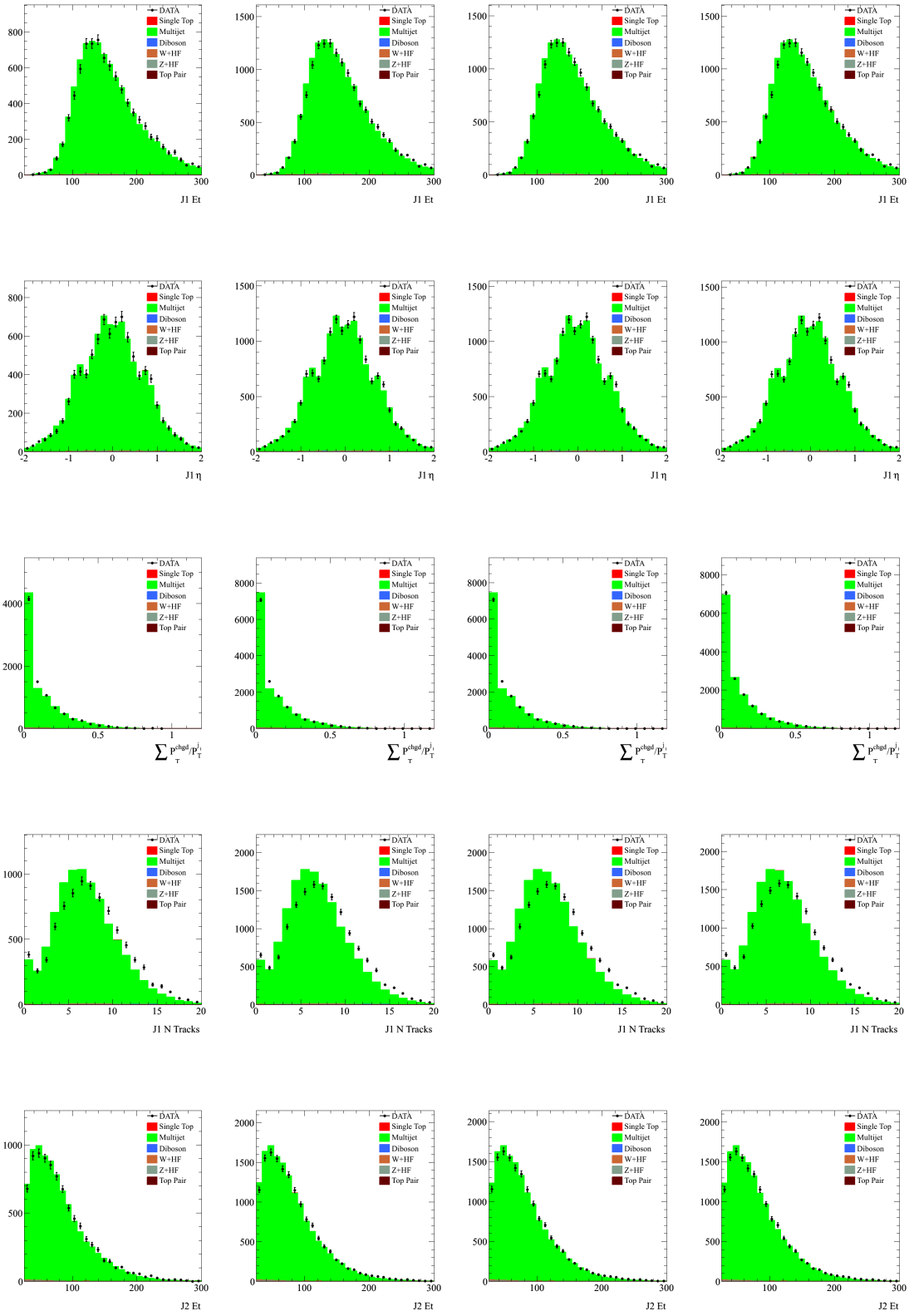


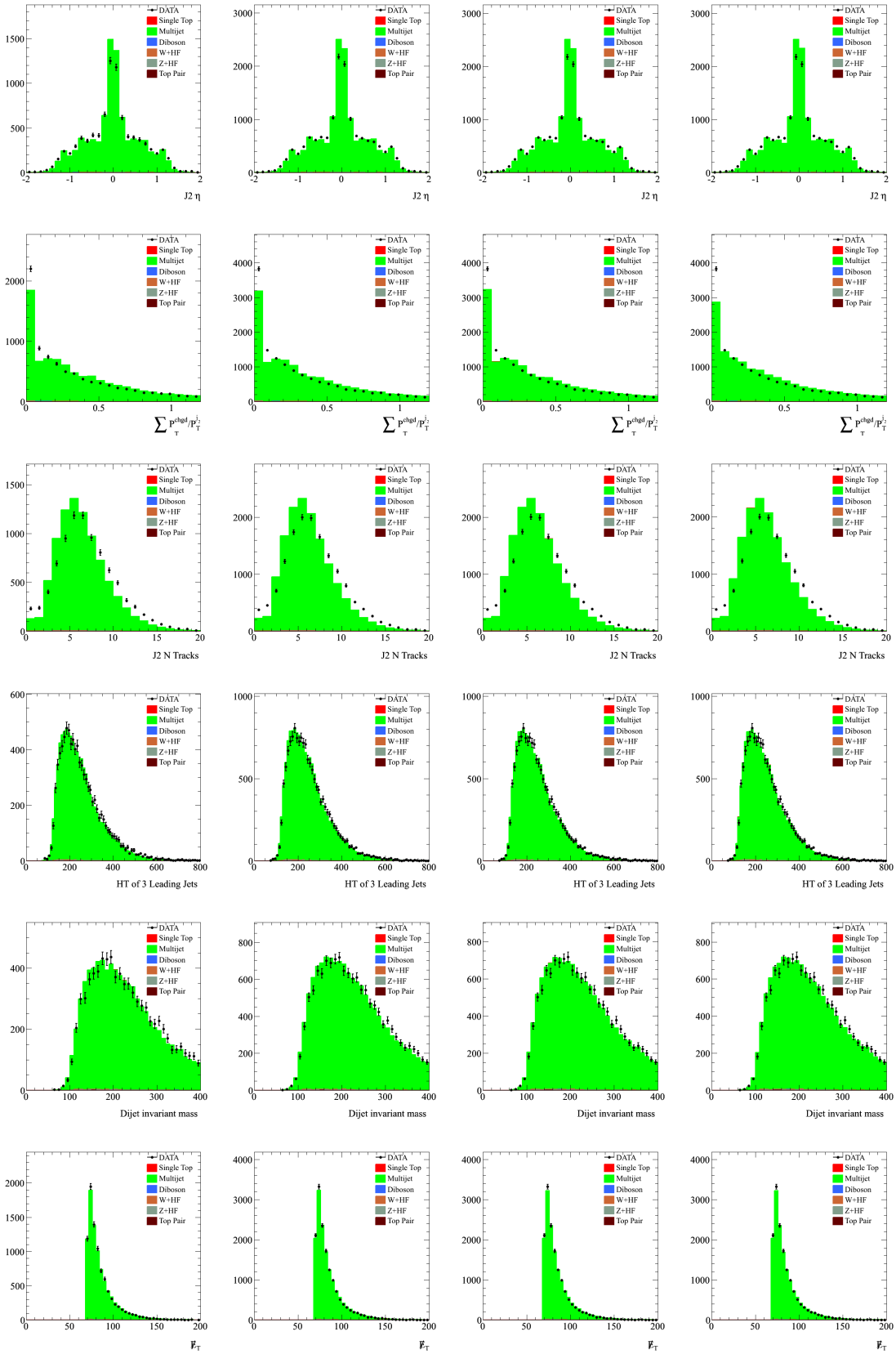

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_\tau^{chgd}/P_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

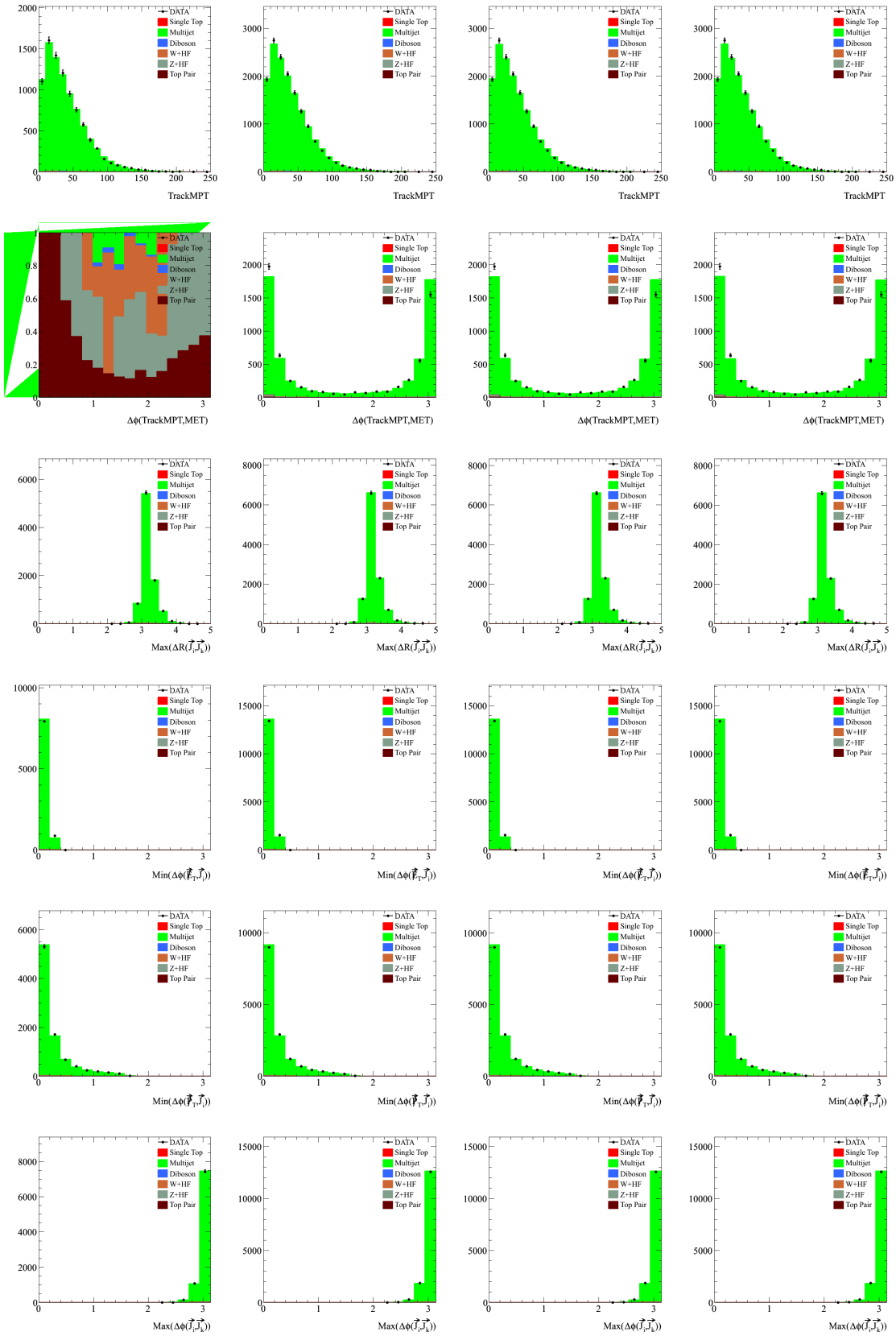

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))

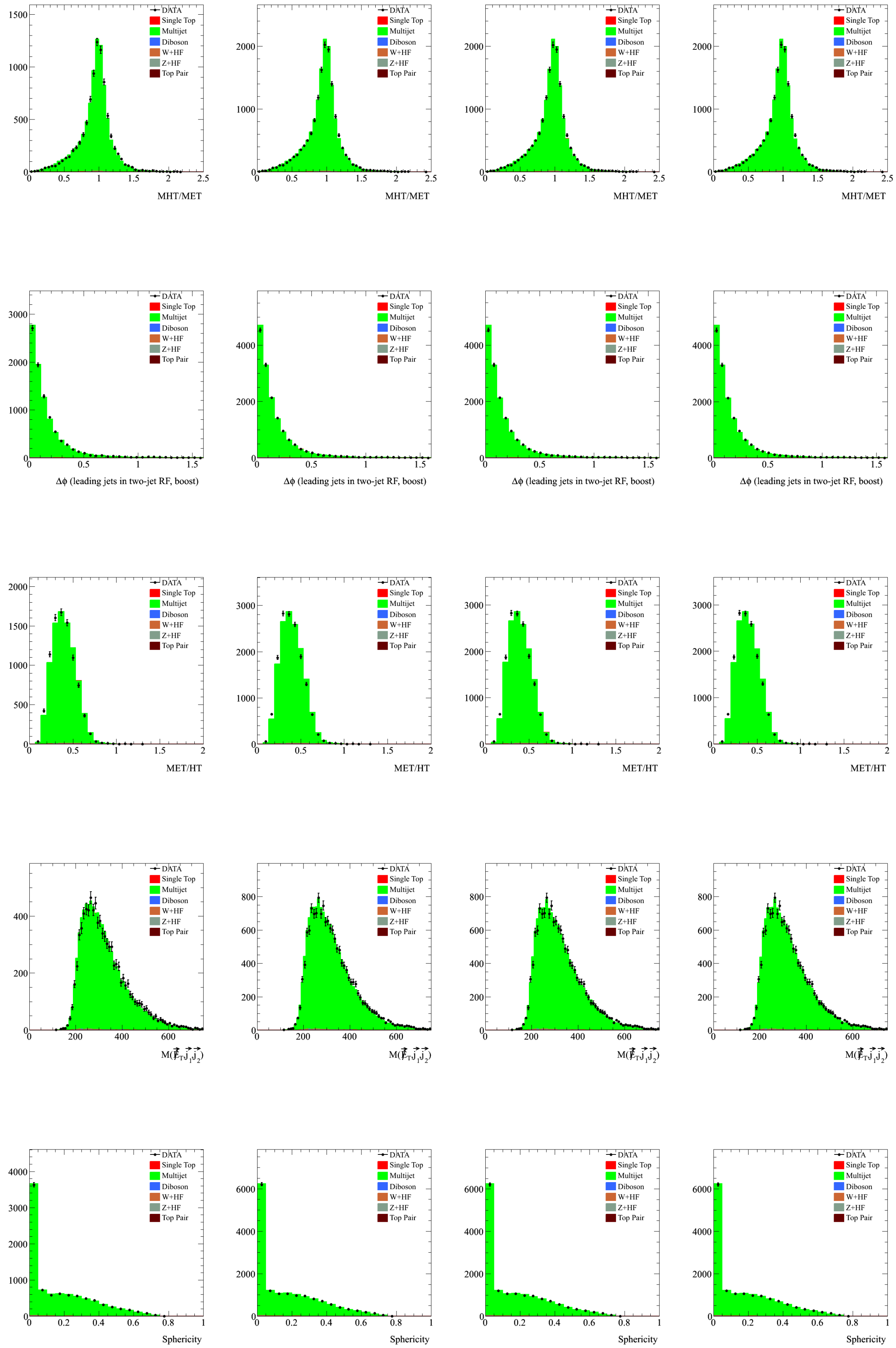

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
$M(\vec{\not{E}}_T\vec{j}_1\vec{j}_2)$
Sphericity

1.1.2 QCDCR/ region

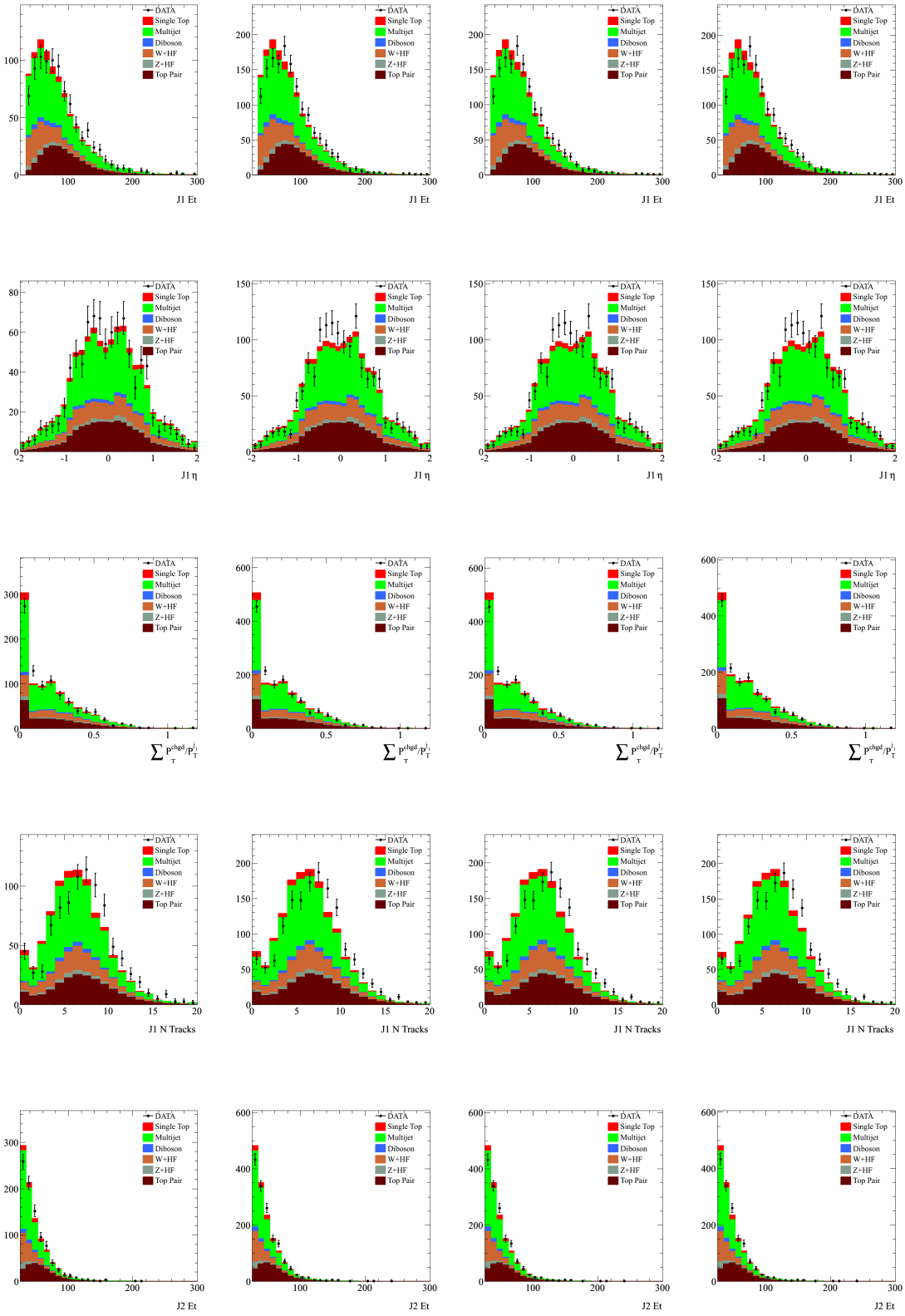


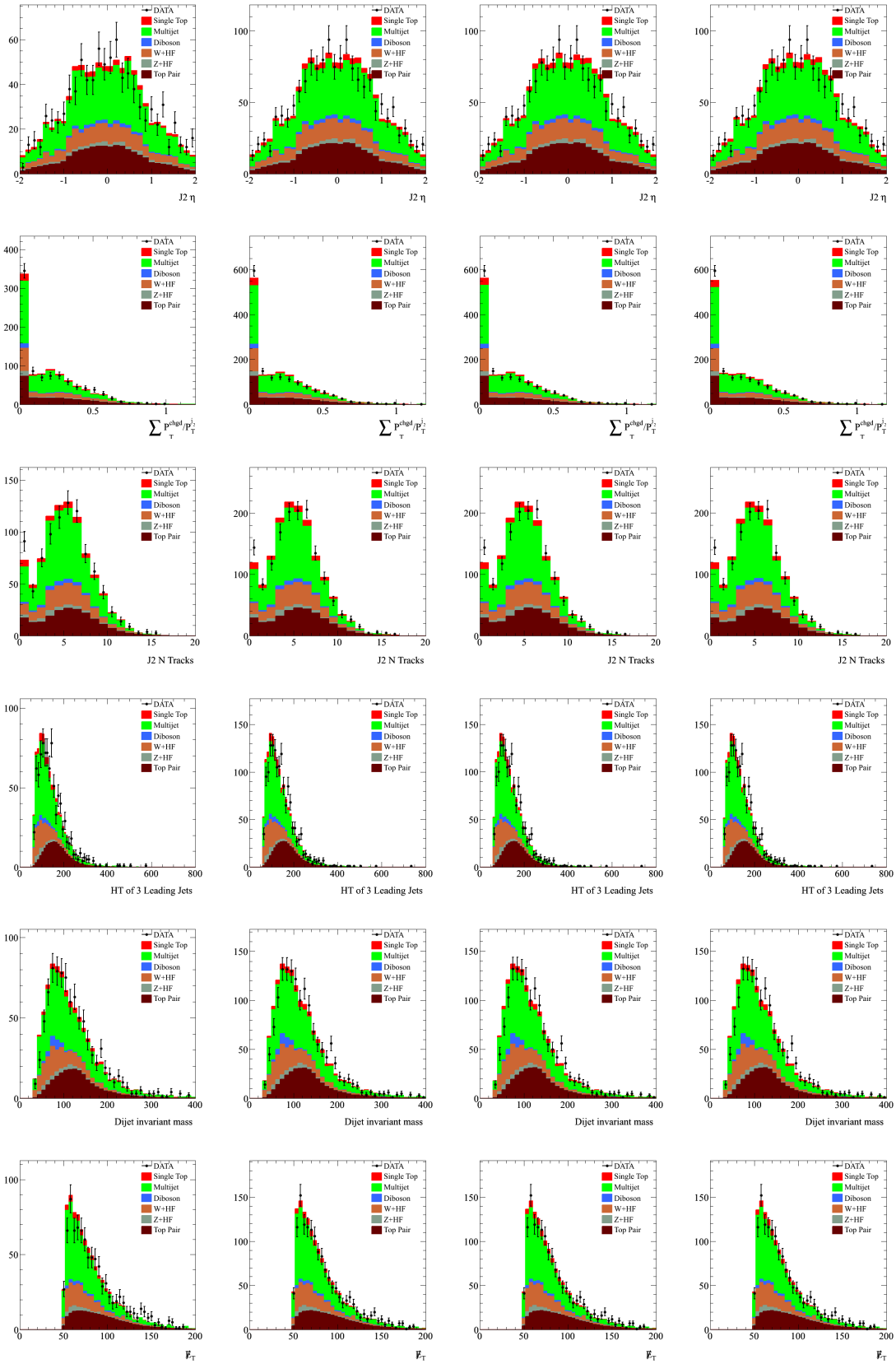

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

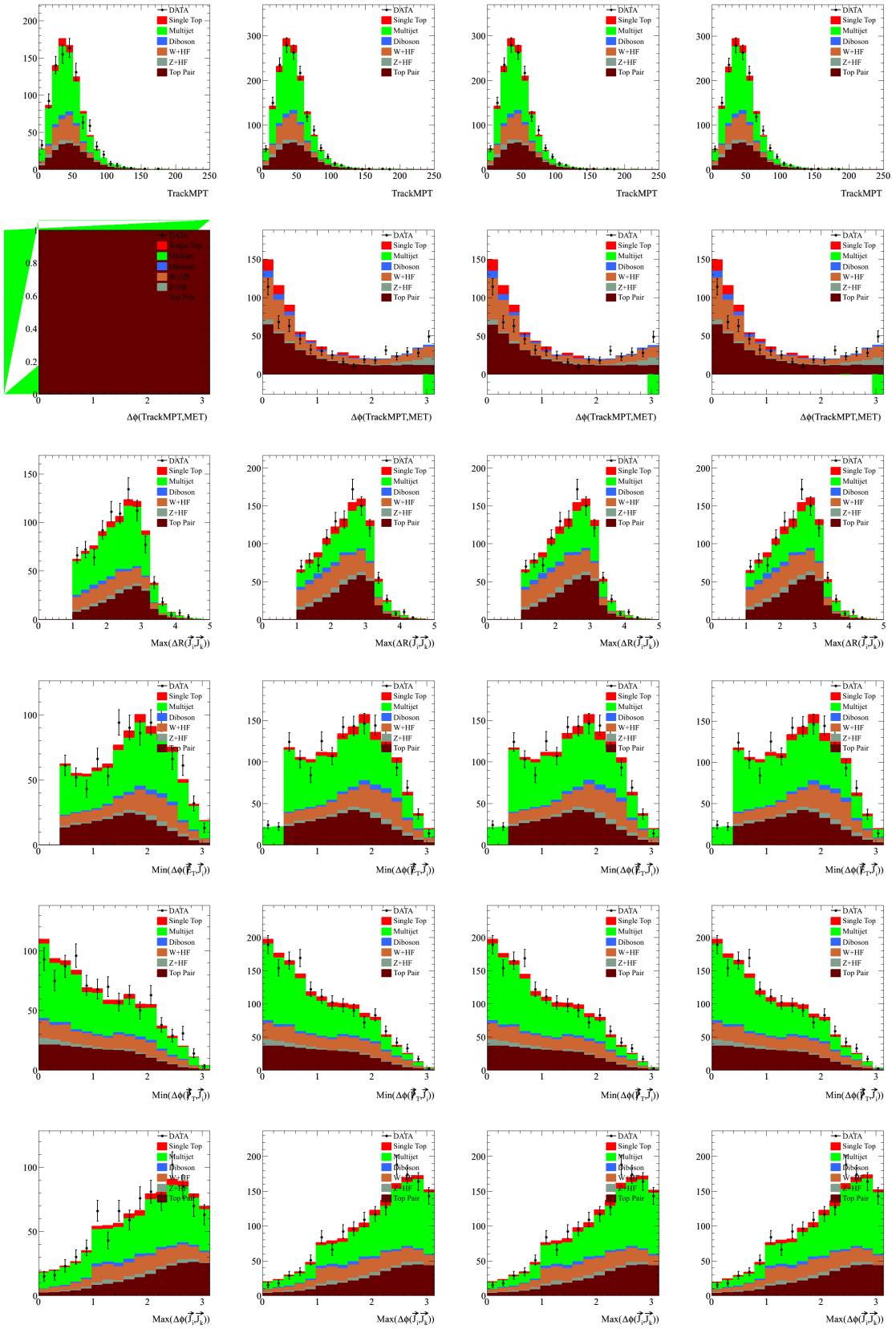

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δϕ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δϕ(P_T,J_i))
Max(Δϕ(J_i,J_k))

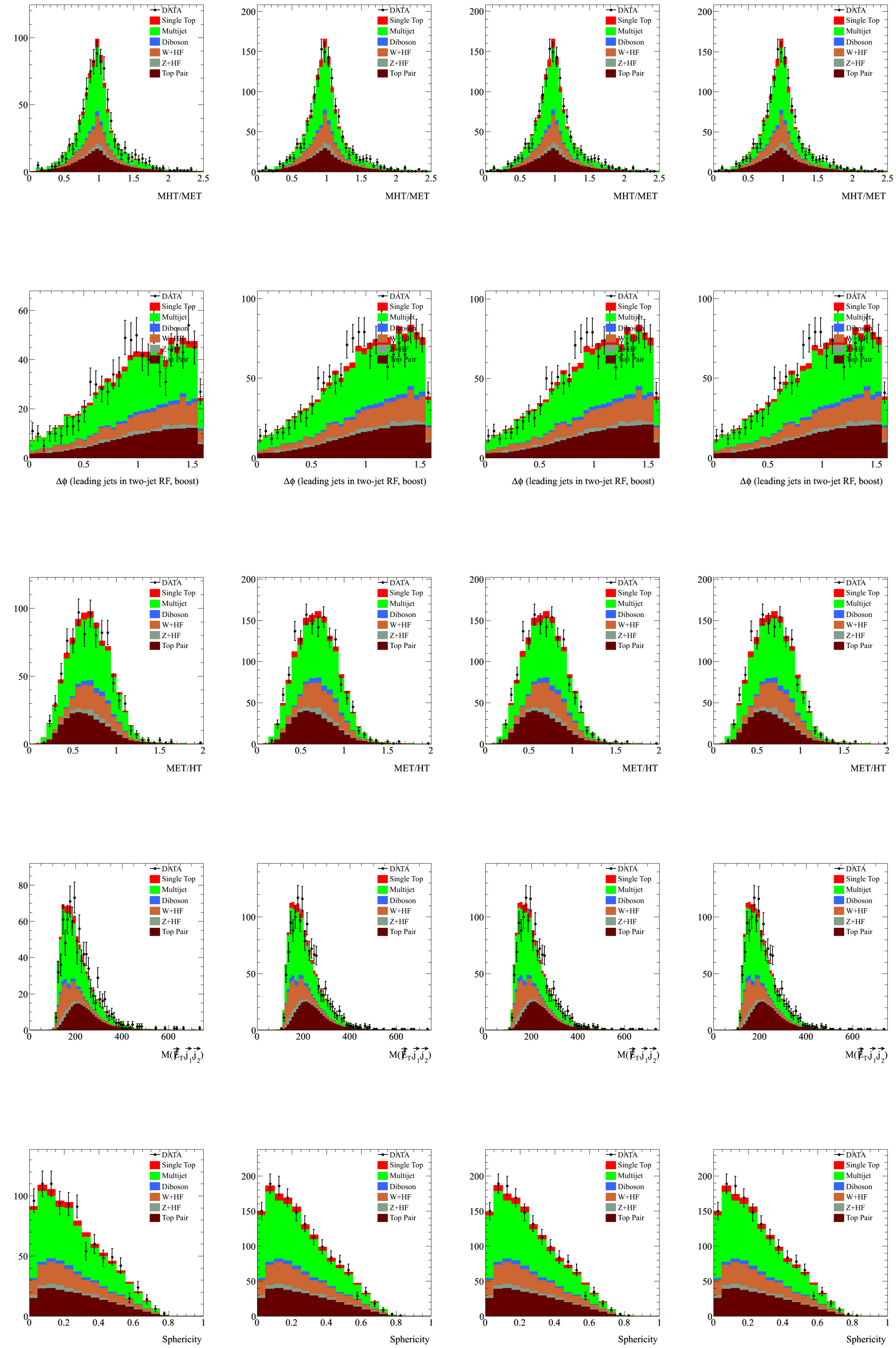

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
M($\vec{\not{E}}_T\vec{j}_1\vec{j}_2$)
Sphericity

1.1.3 EwkCR/ region



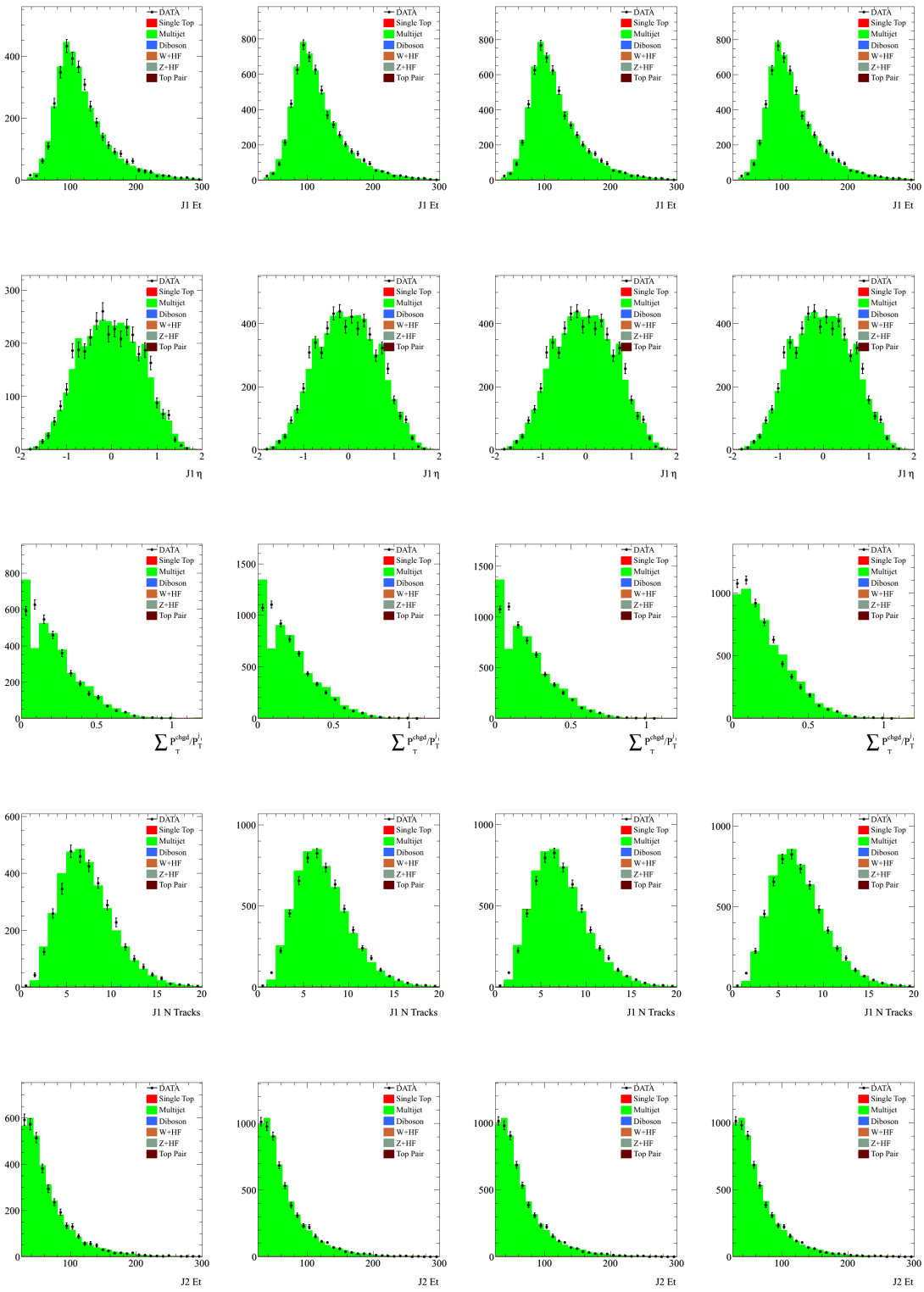

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum_{\tau} P_{T}^{chgd}/P_{T}^{j_2}$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_{T}$

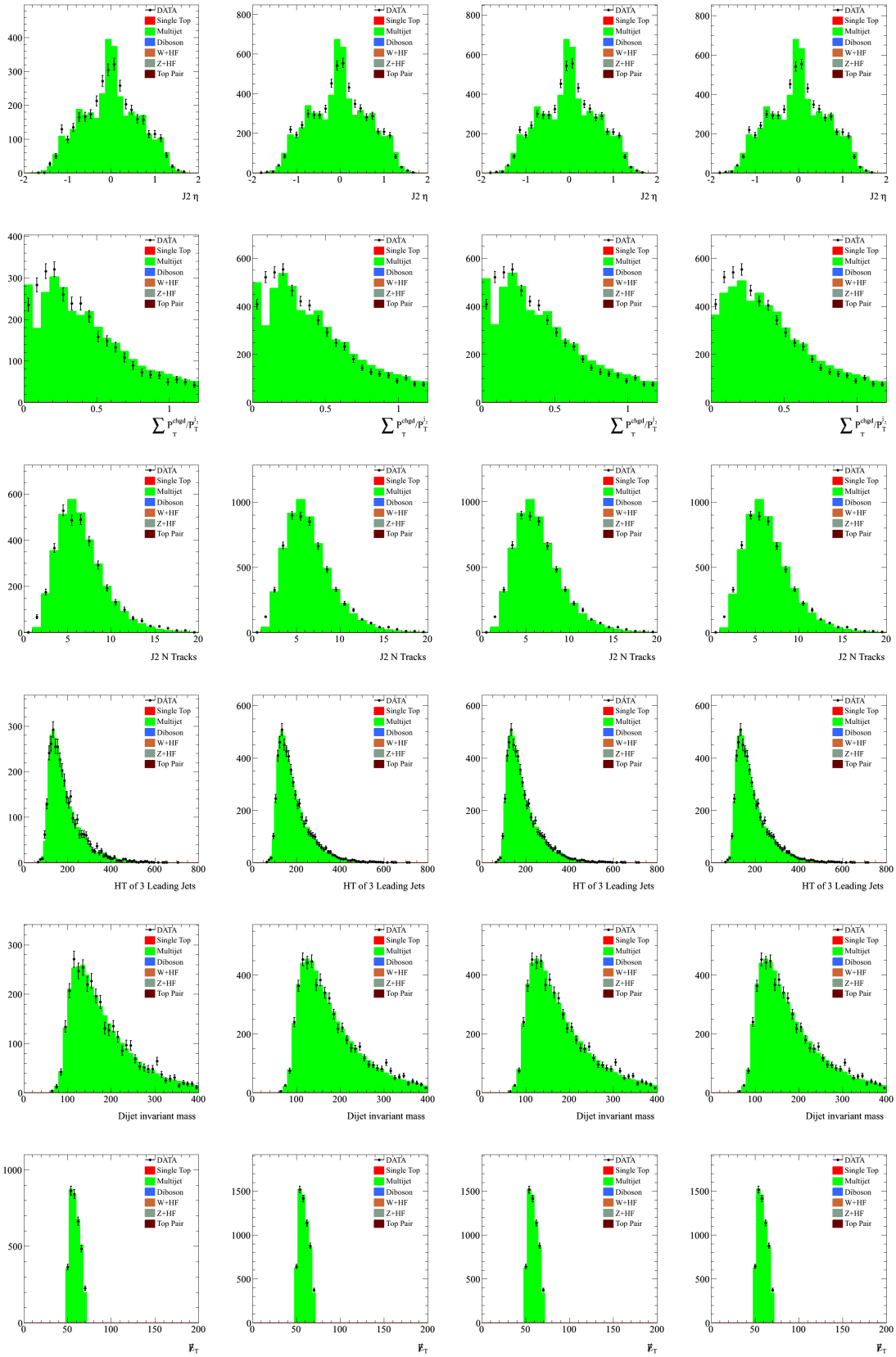

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))

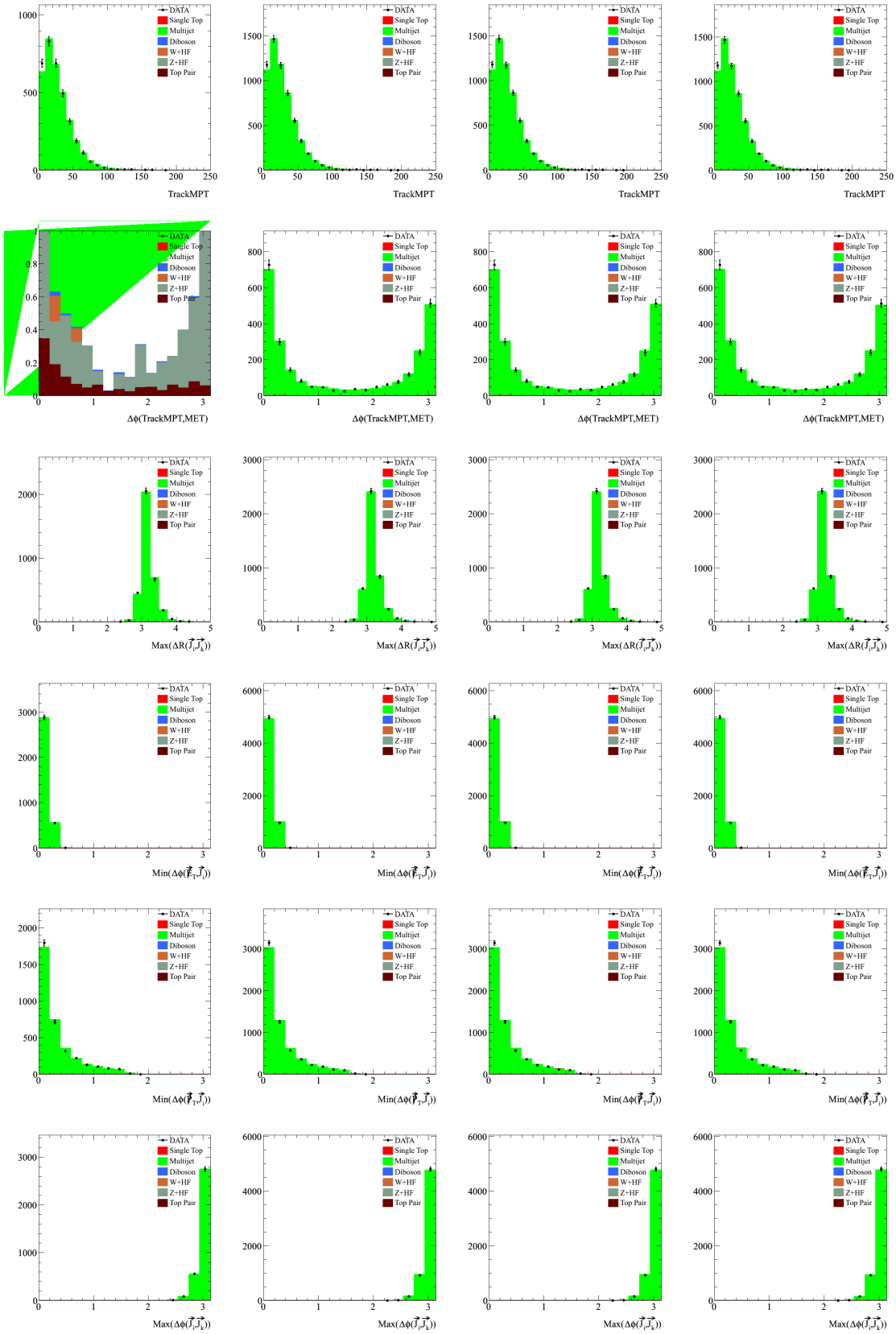

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
$M(\vec{E}_T\vec{J}_1\vec{J}_2)$
Sphericity

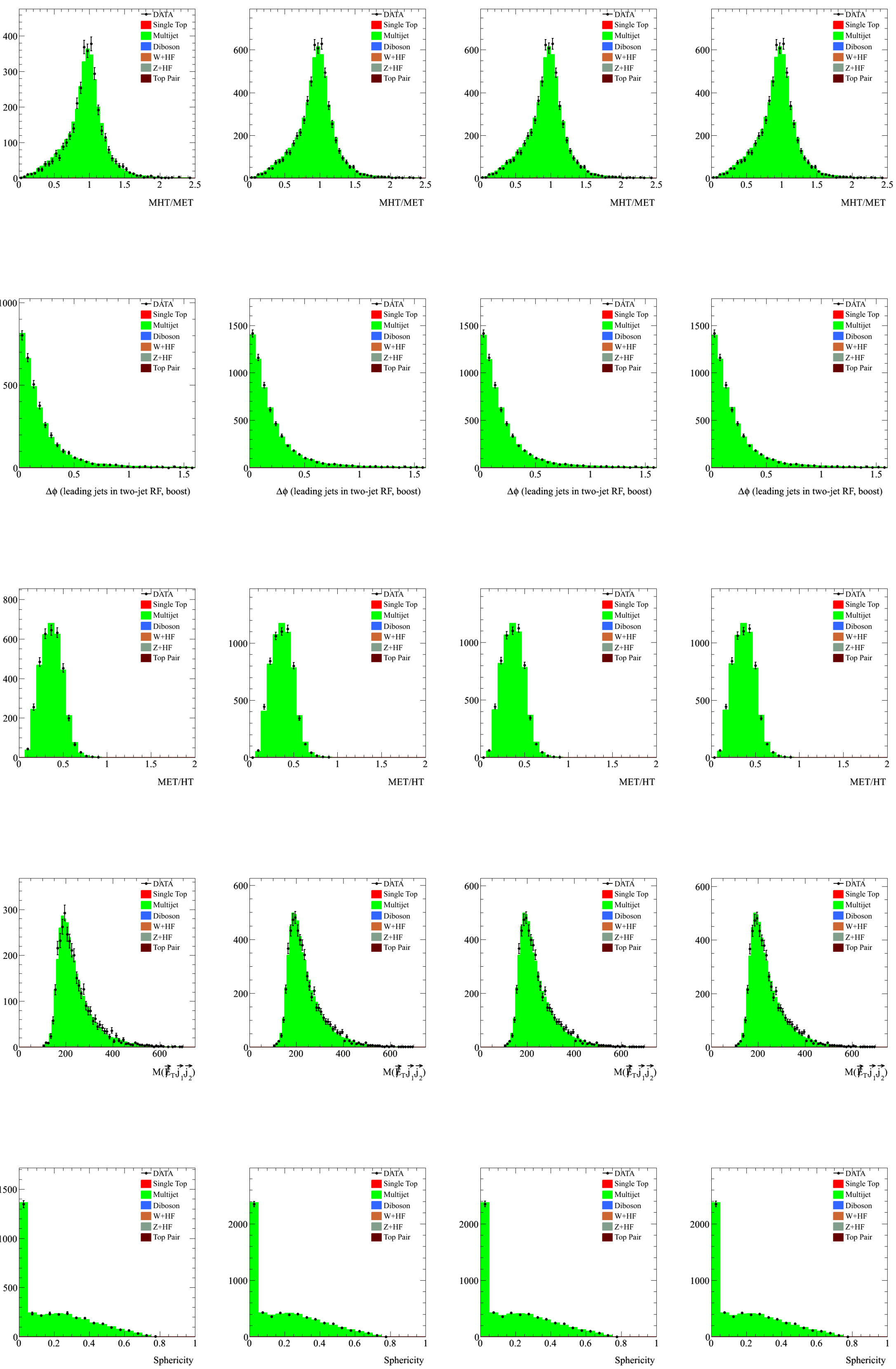
1.2 Category: SJ (in order of 4 approaches)

1.2.1 TRM/ region

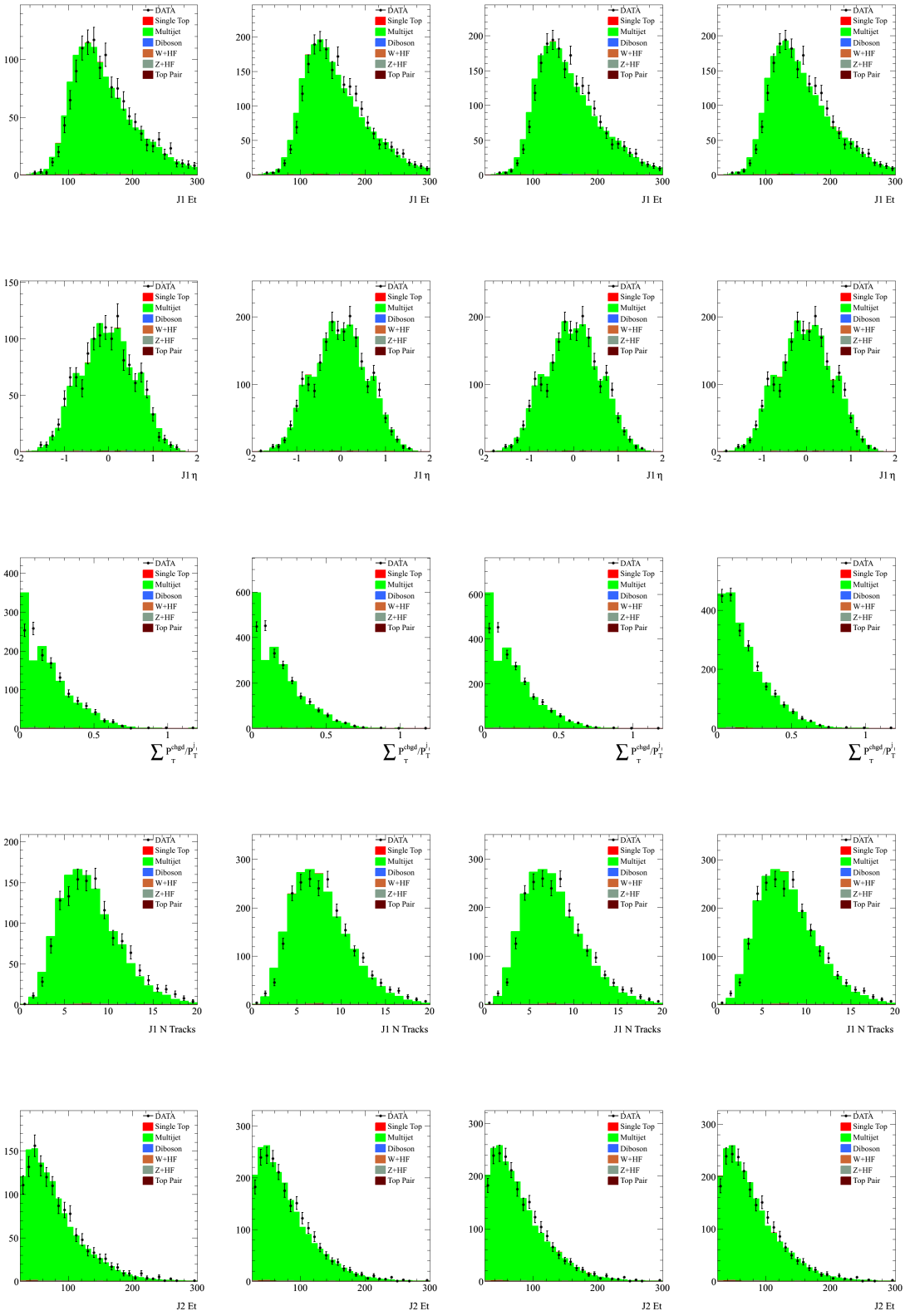


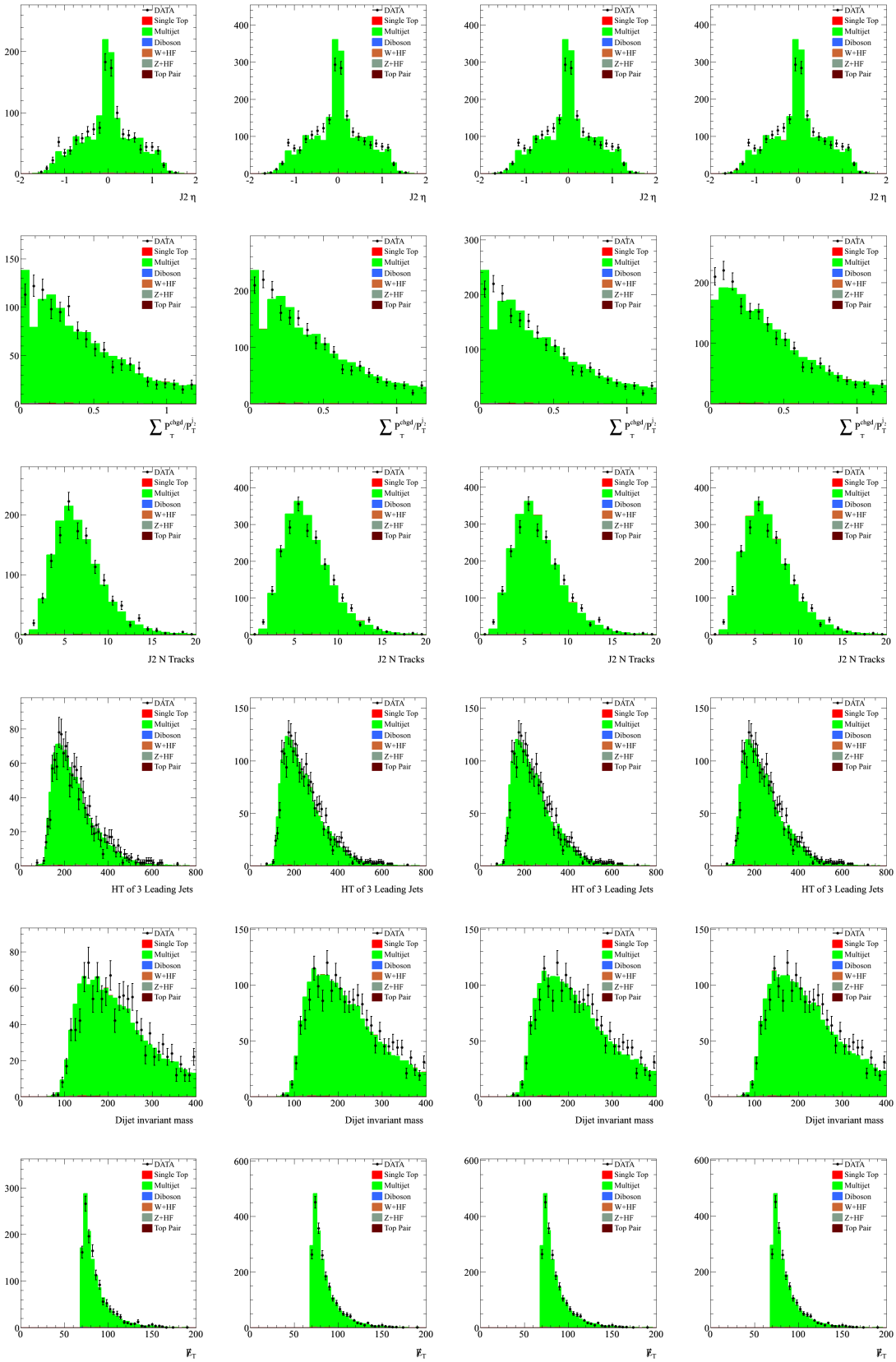

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

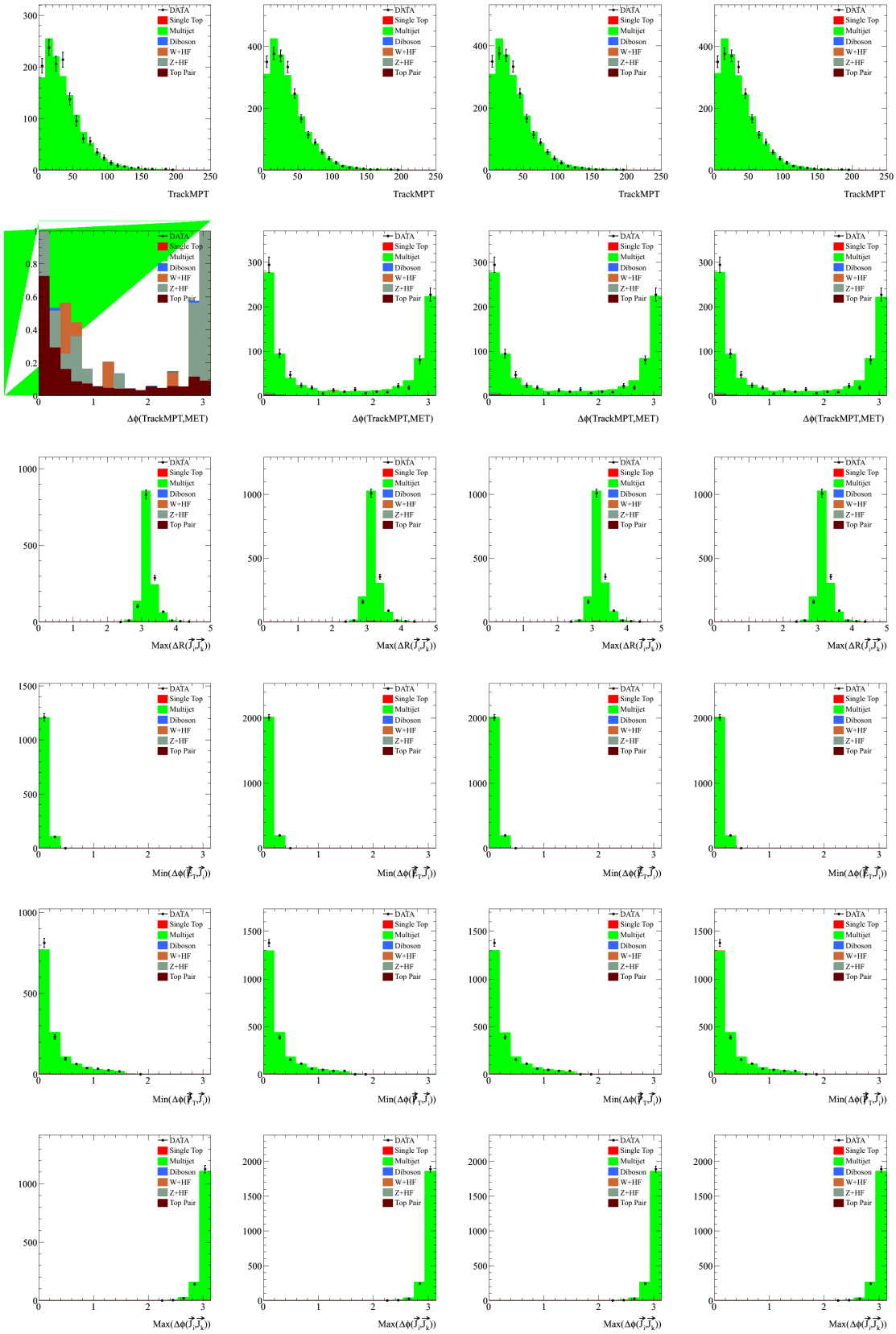

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(j⃗,j⃗))
Min(Δφ(p⃗T,j⃗))
Max(Δφ(j⃗,j⃗))

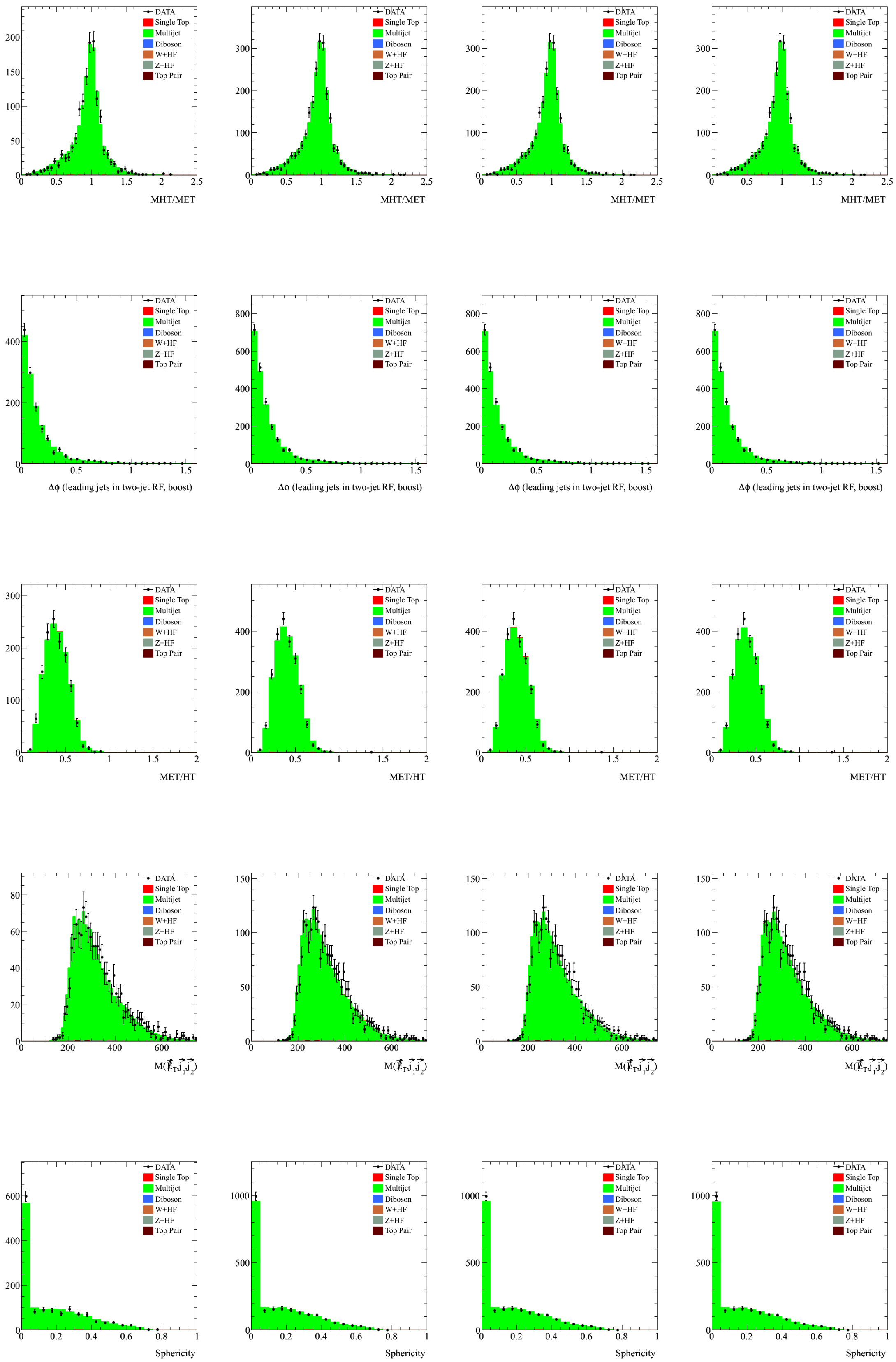

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
M(E̸T j1 j2)
Sphericity

1.2.2 QCDCR/ region

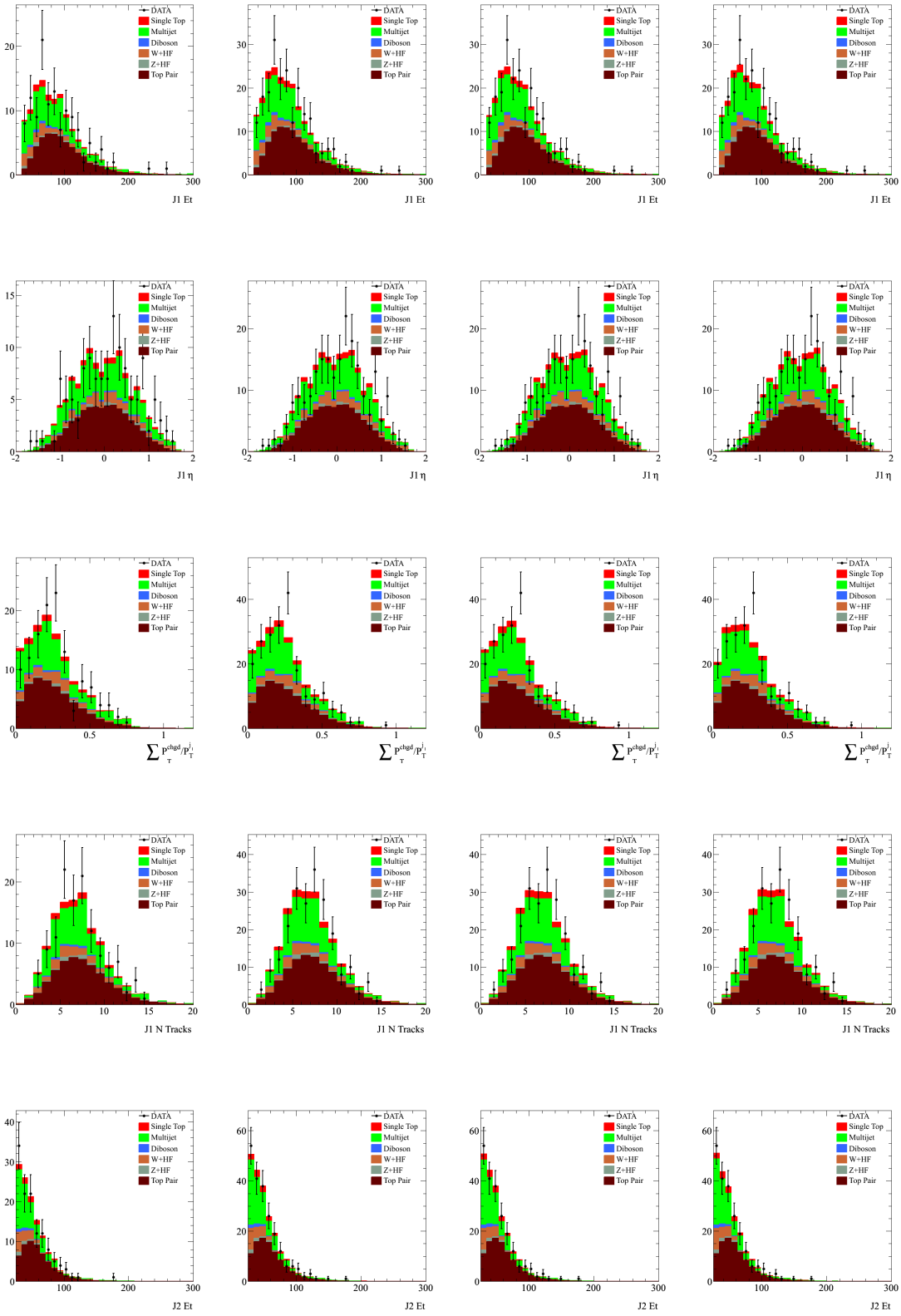


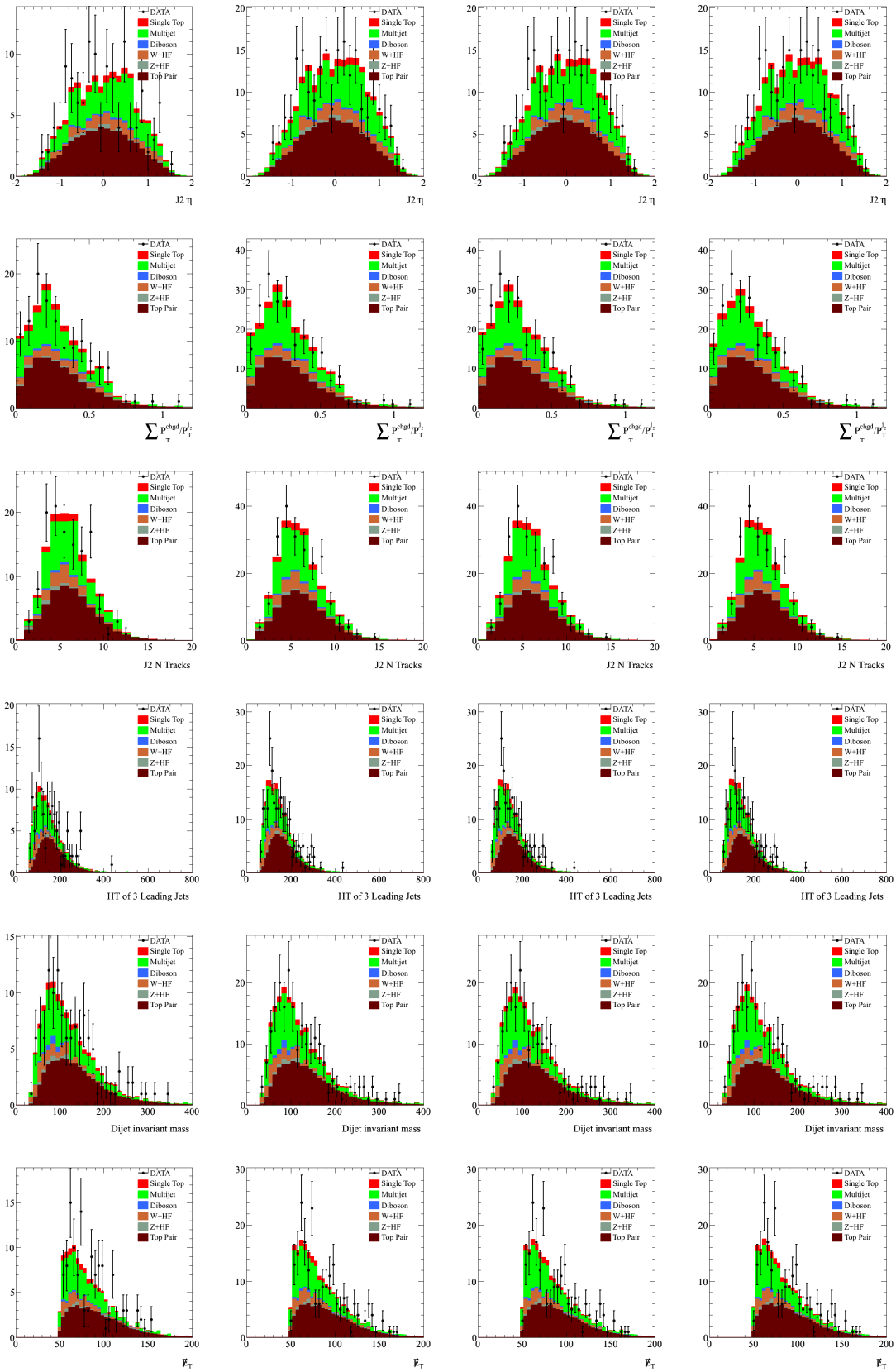

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

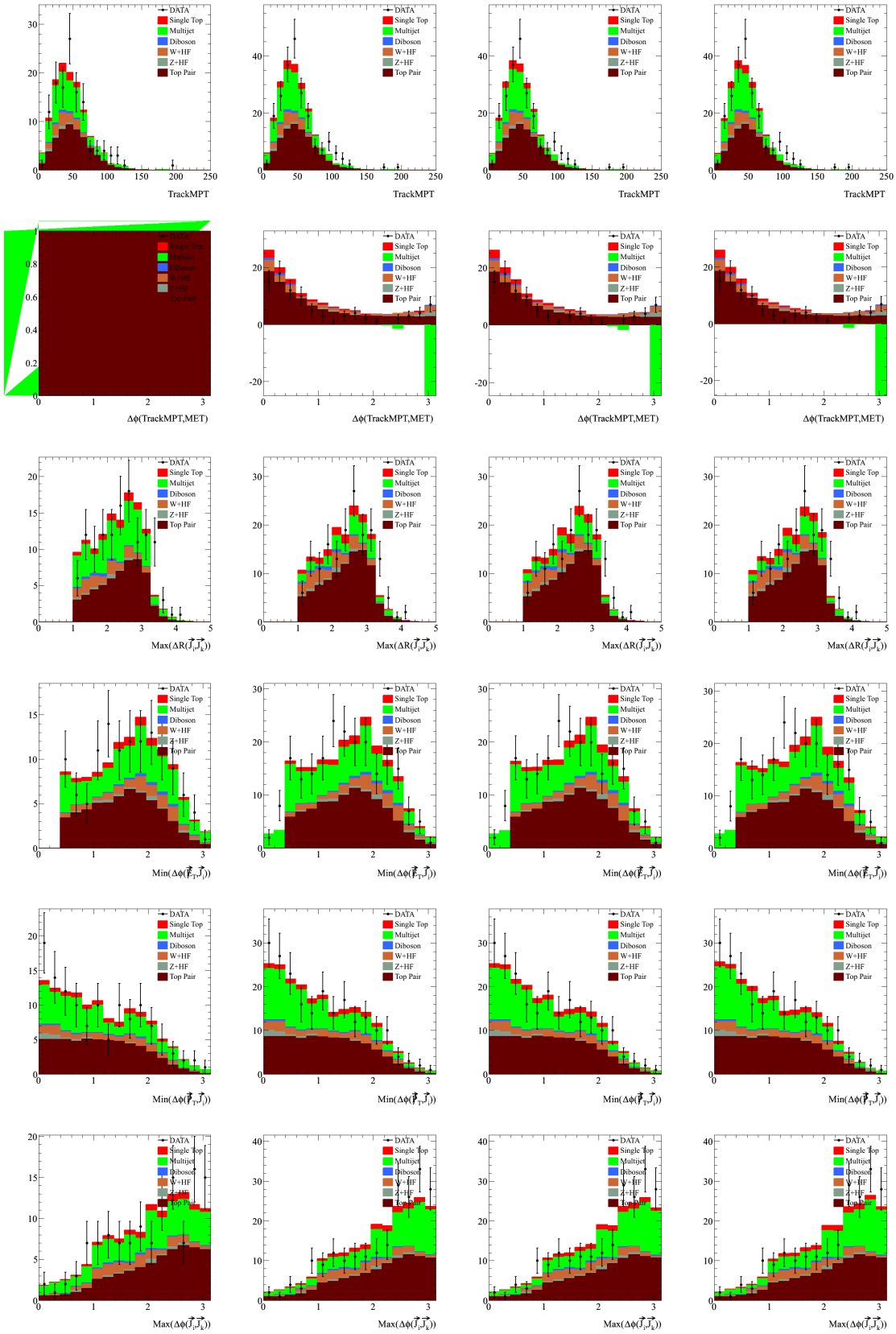

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))

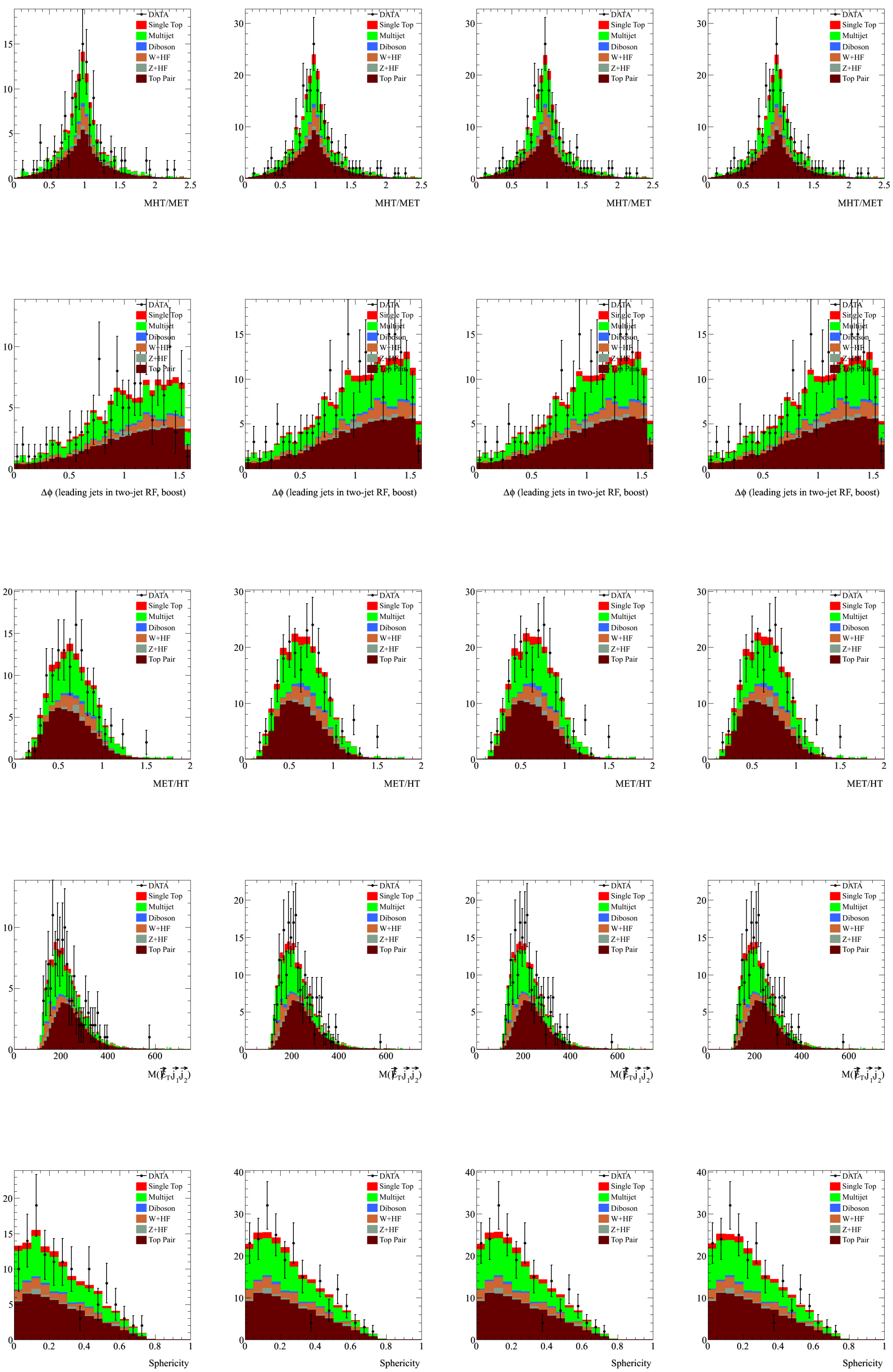

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δφ (leading jets in two-jet RF, boost)
MET/HT
$M(\vec{E}_T \vec{j}_1 \vec{j}_2)$
Sphericity

1.2.3 EwkCR/ region



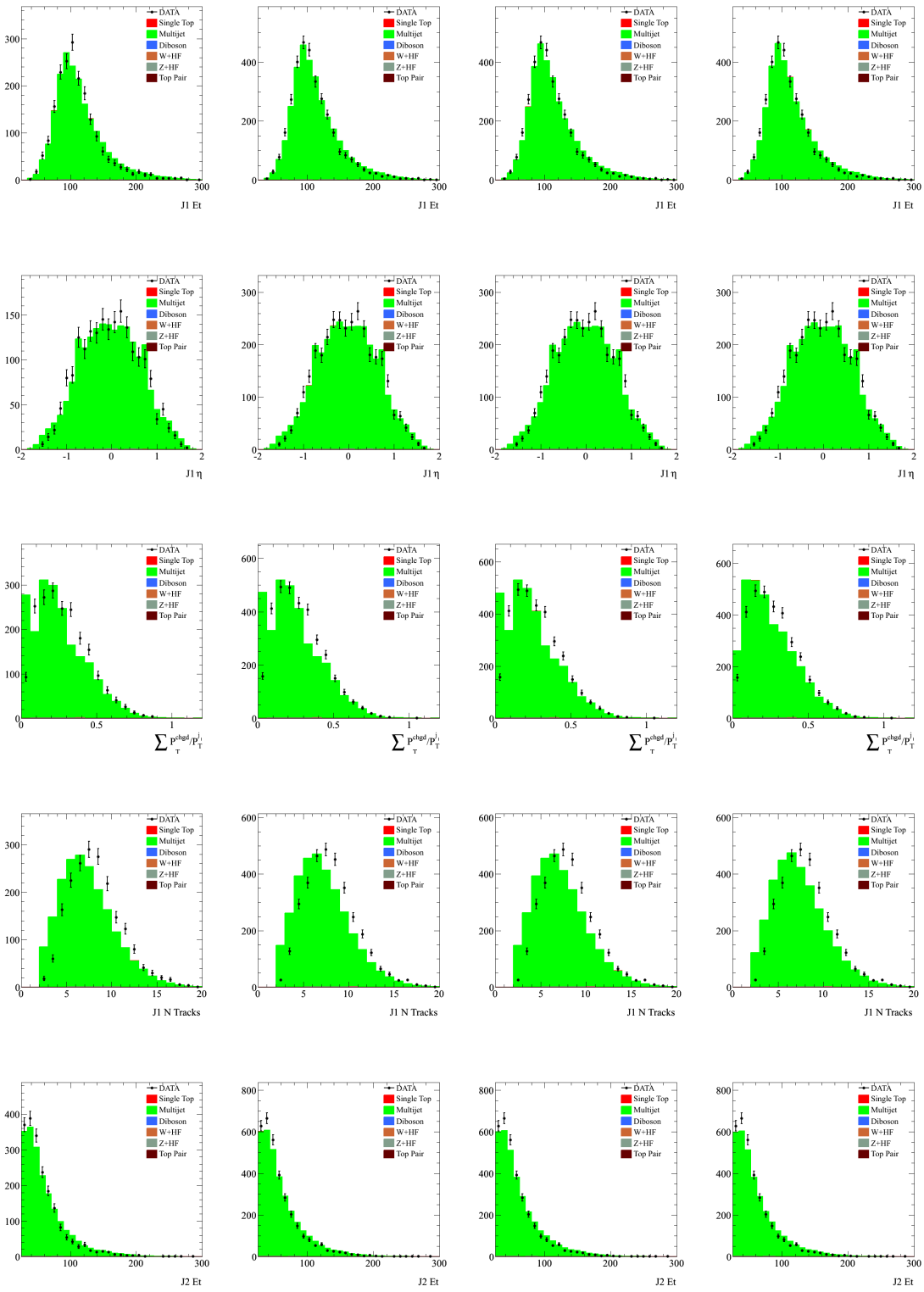

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/P_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

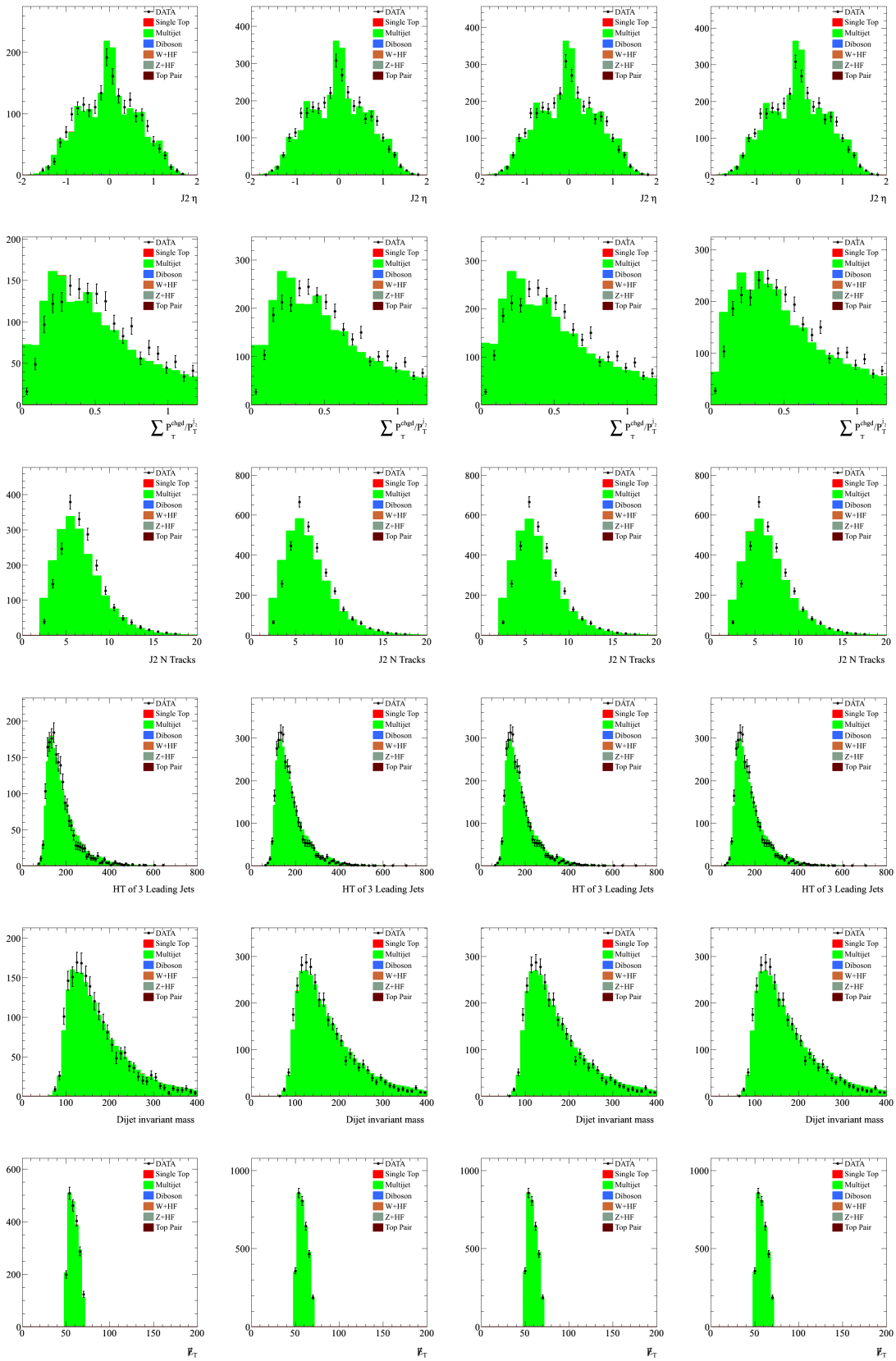

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))

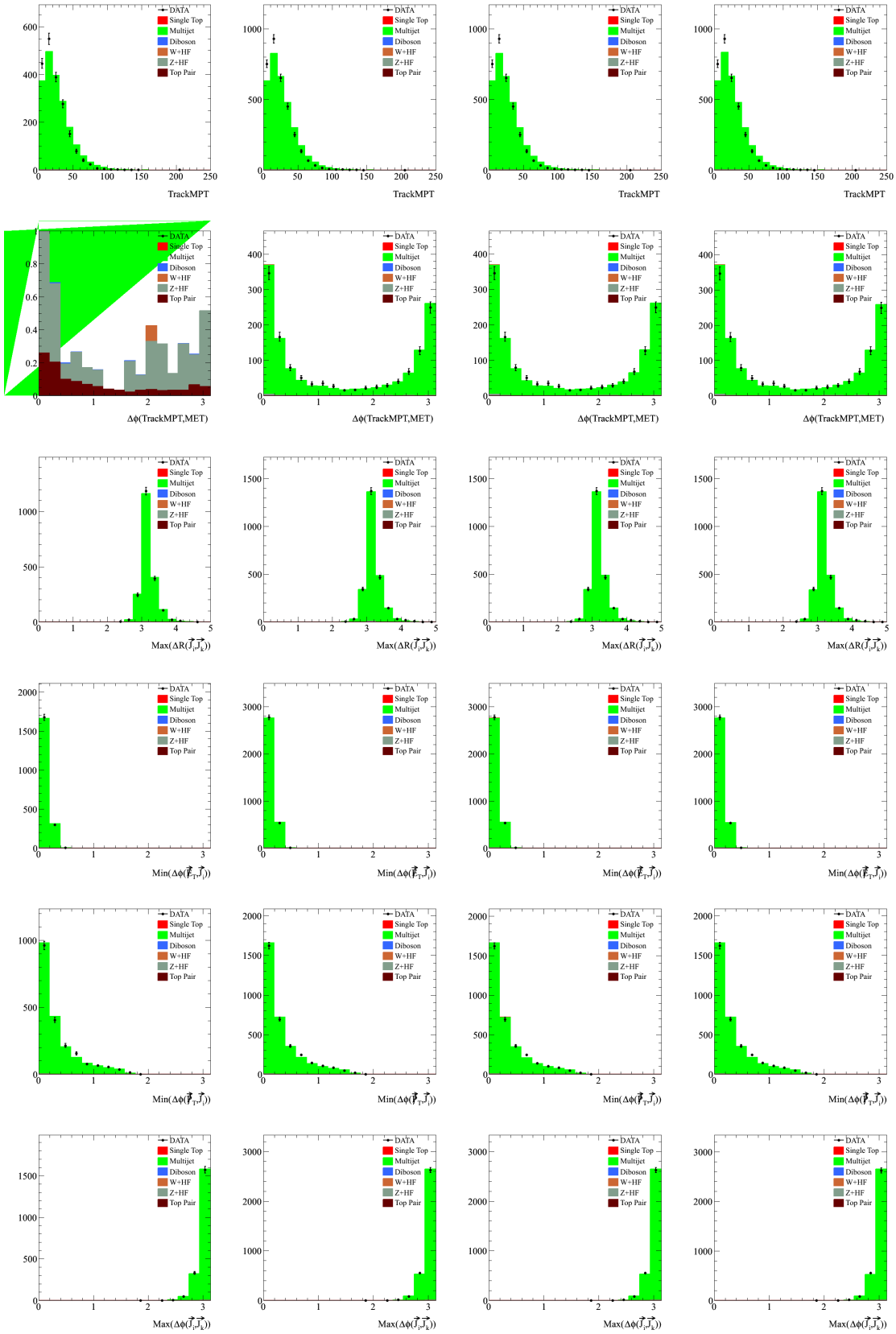

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δφ (leading jets in two-jet RF, boost)
MET/HT
Sphericity

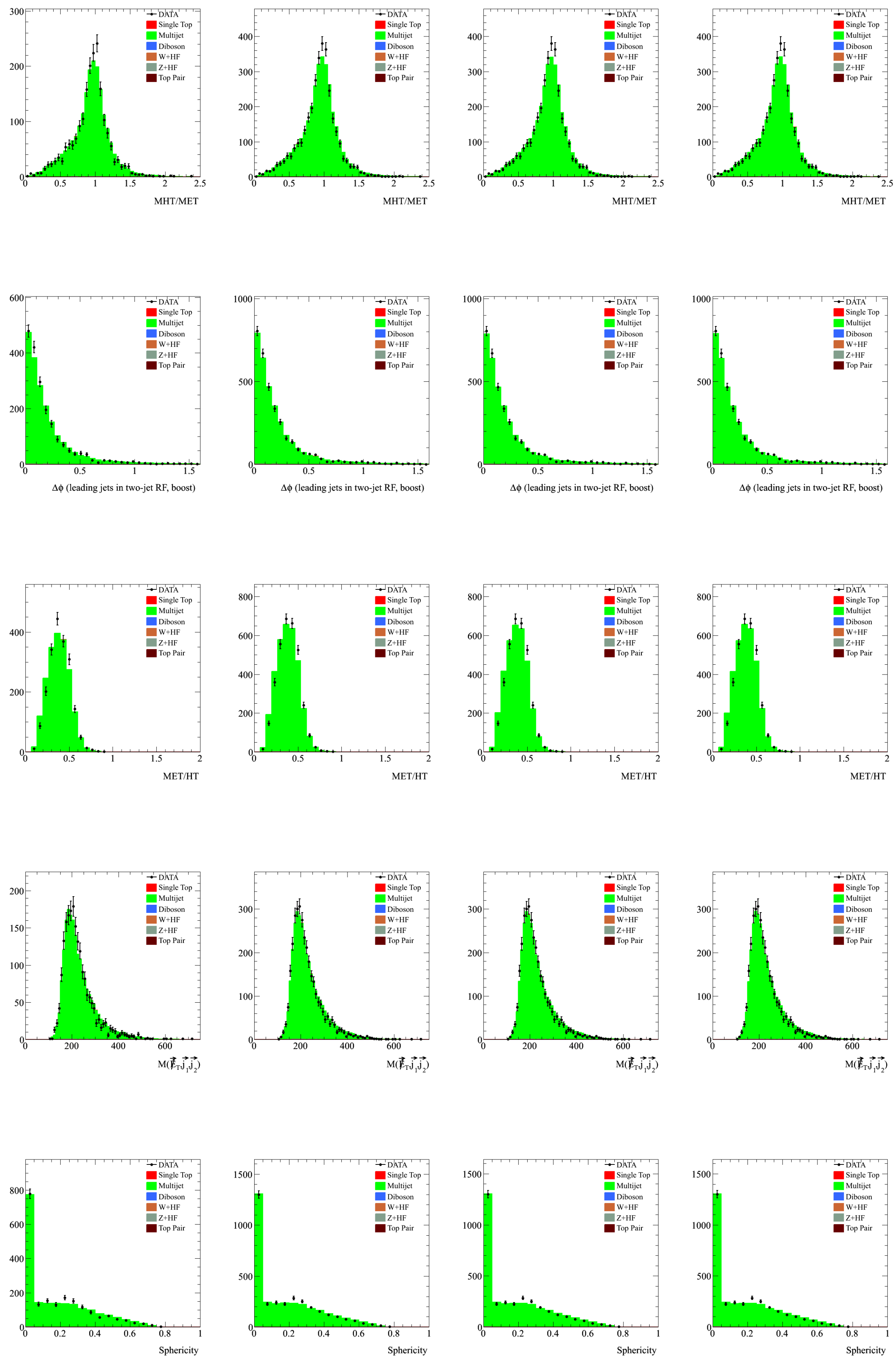
1.3 Category: SS (in order of 4 approaches)

1.3.1 TRM/ region

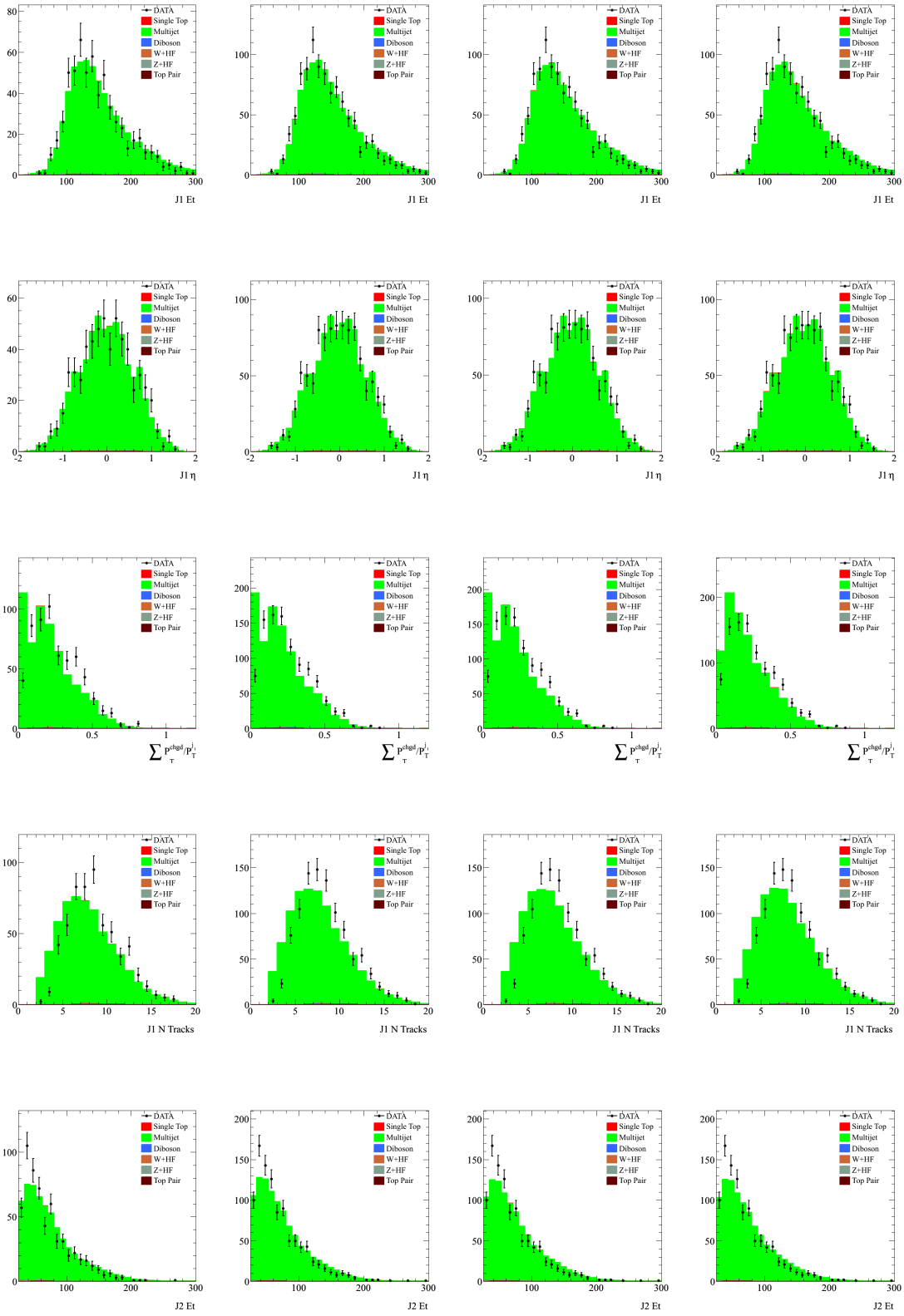


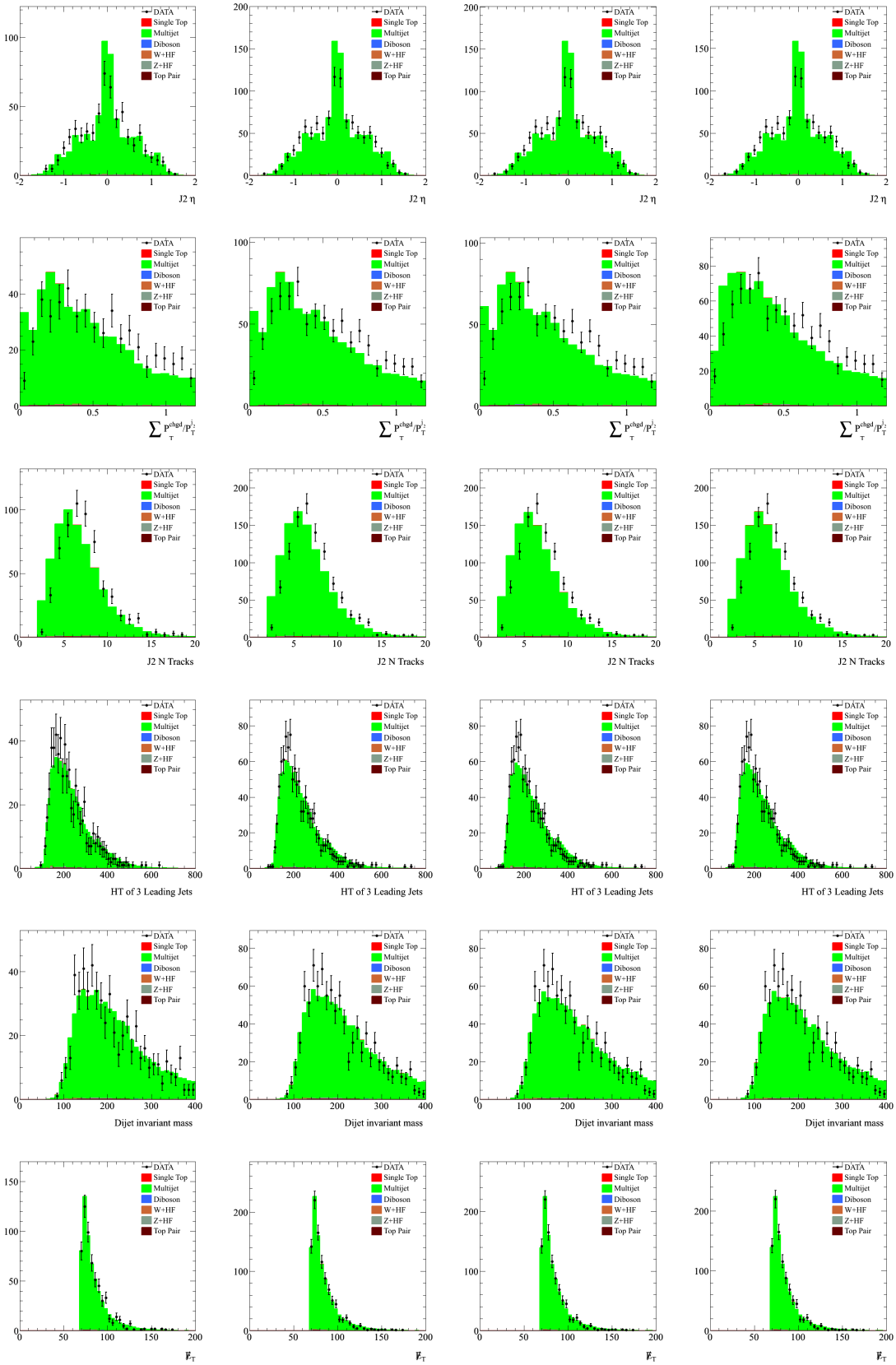

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

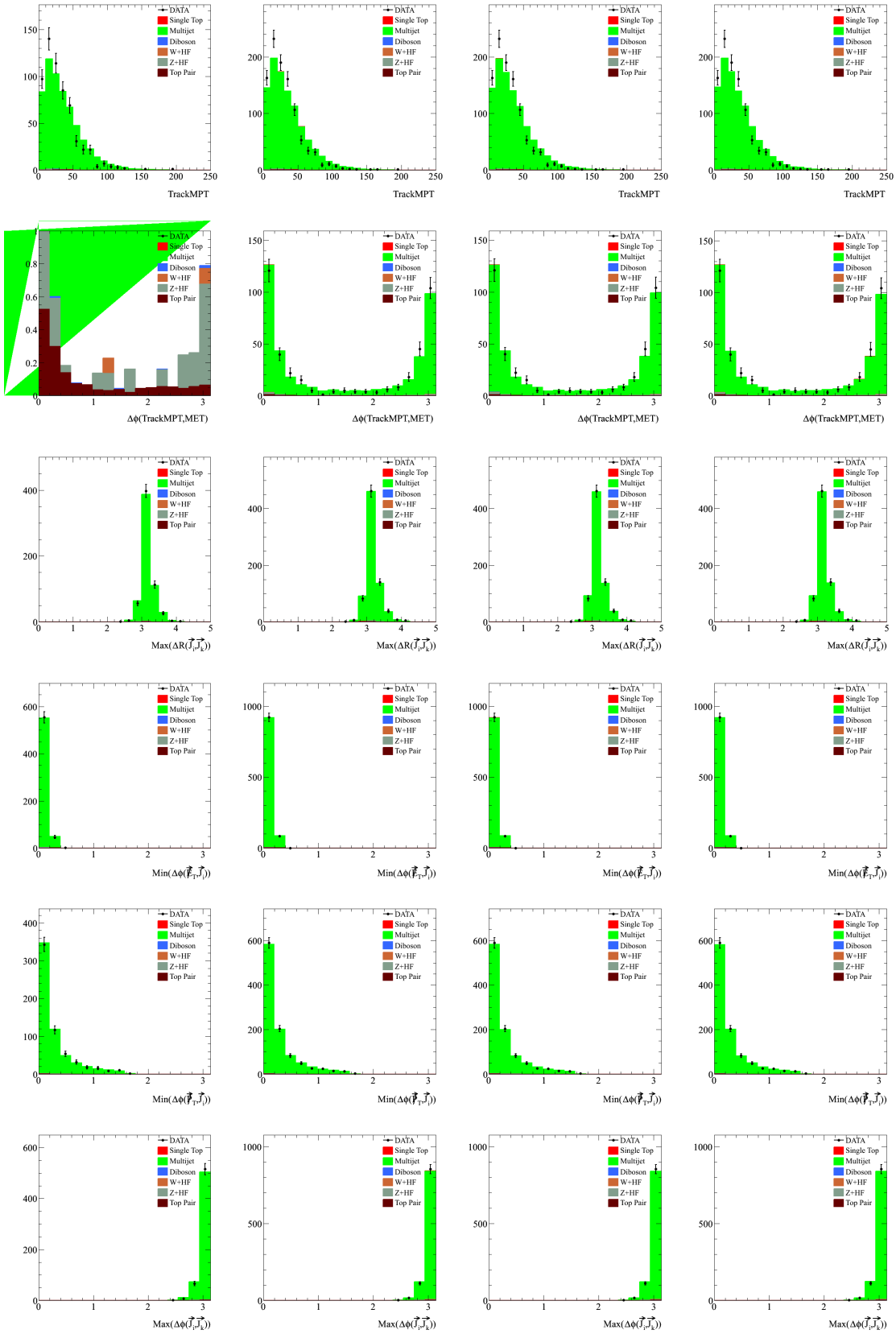

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))

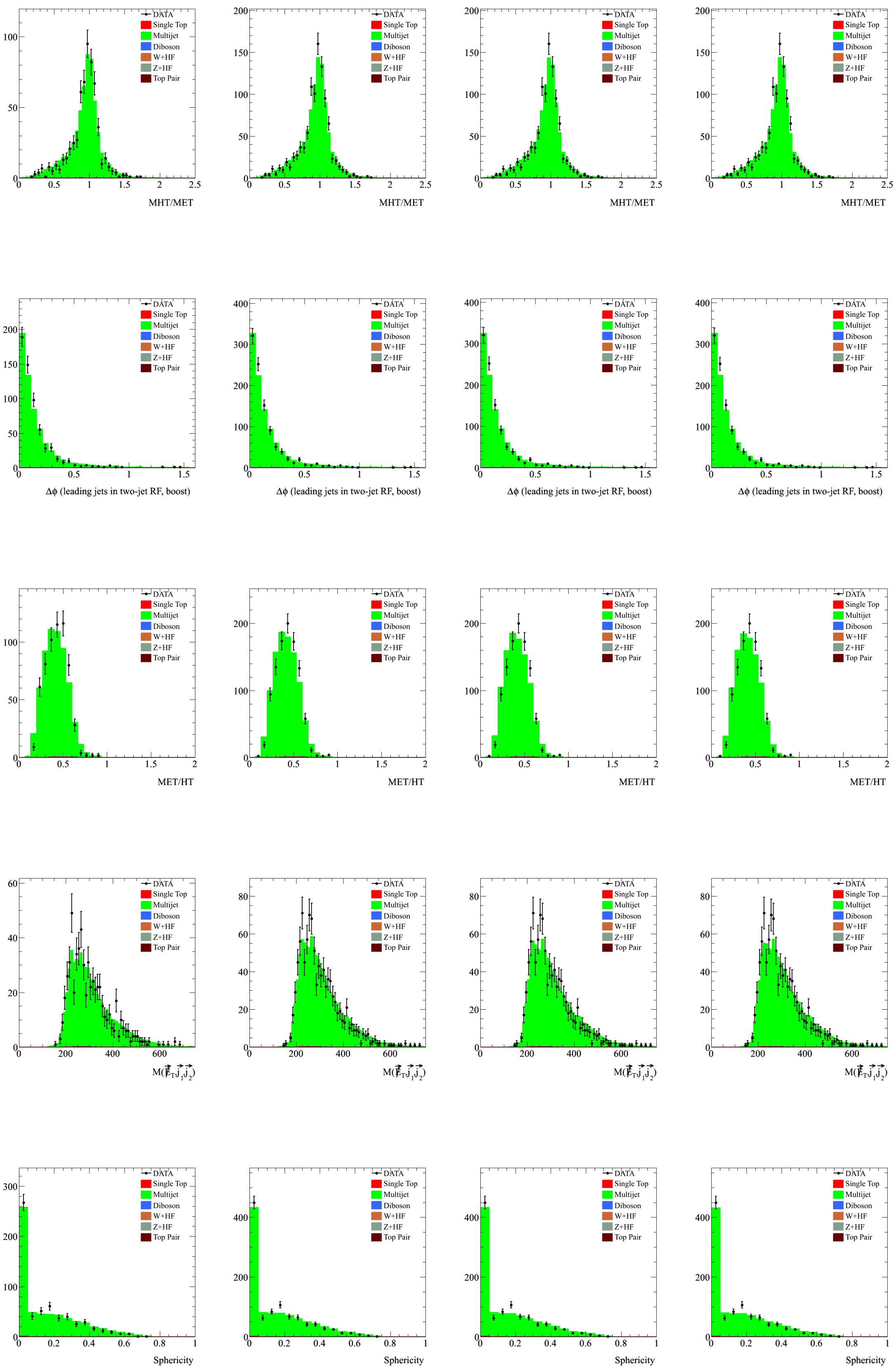

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
Sphericity

1.3.2 QCDCR/ region

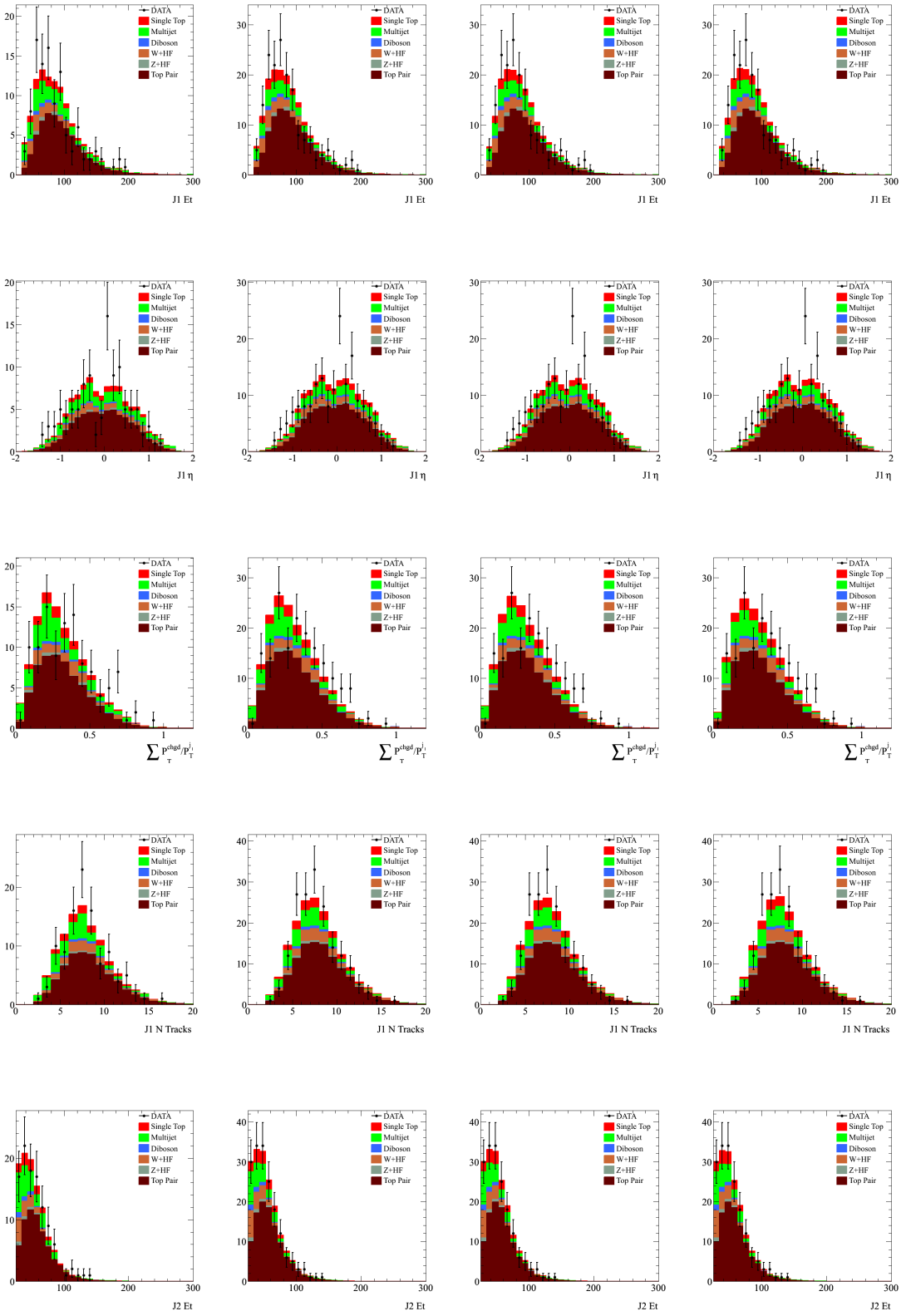


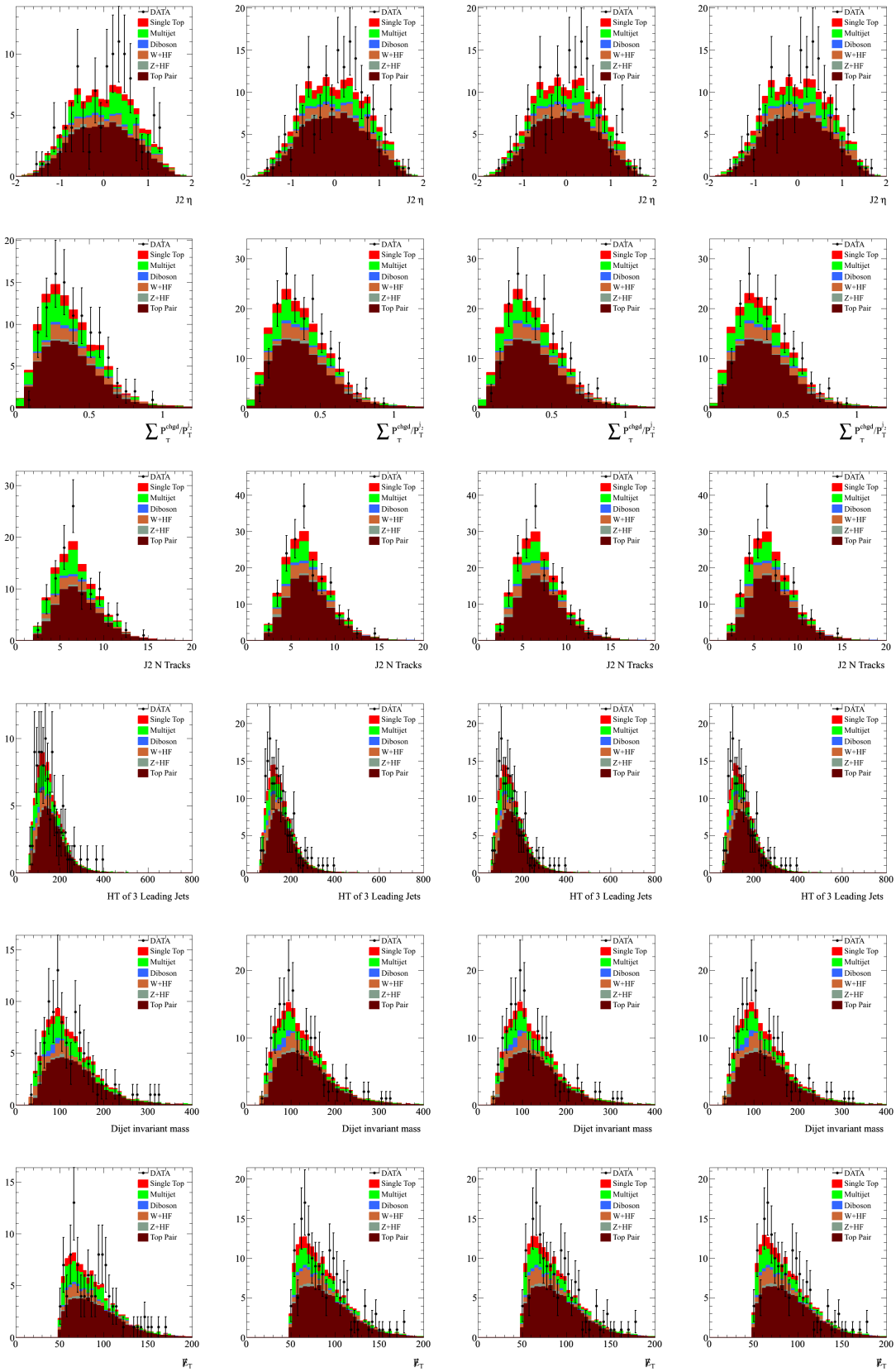

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

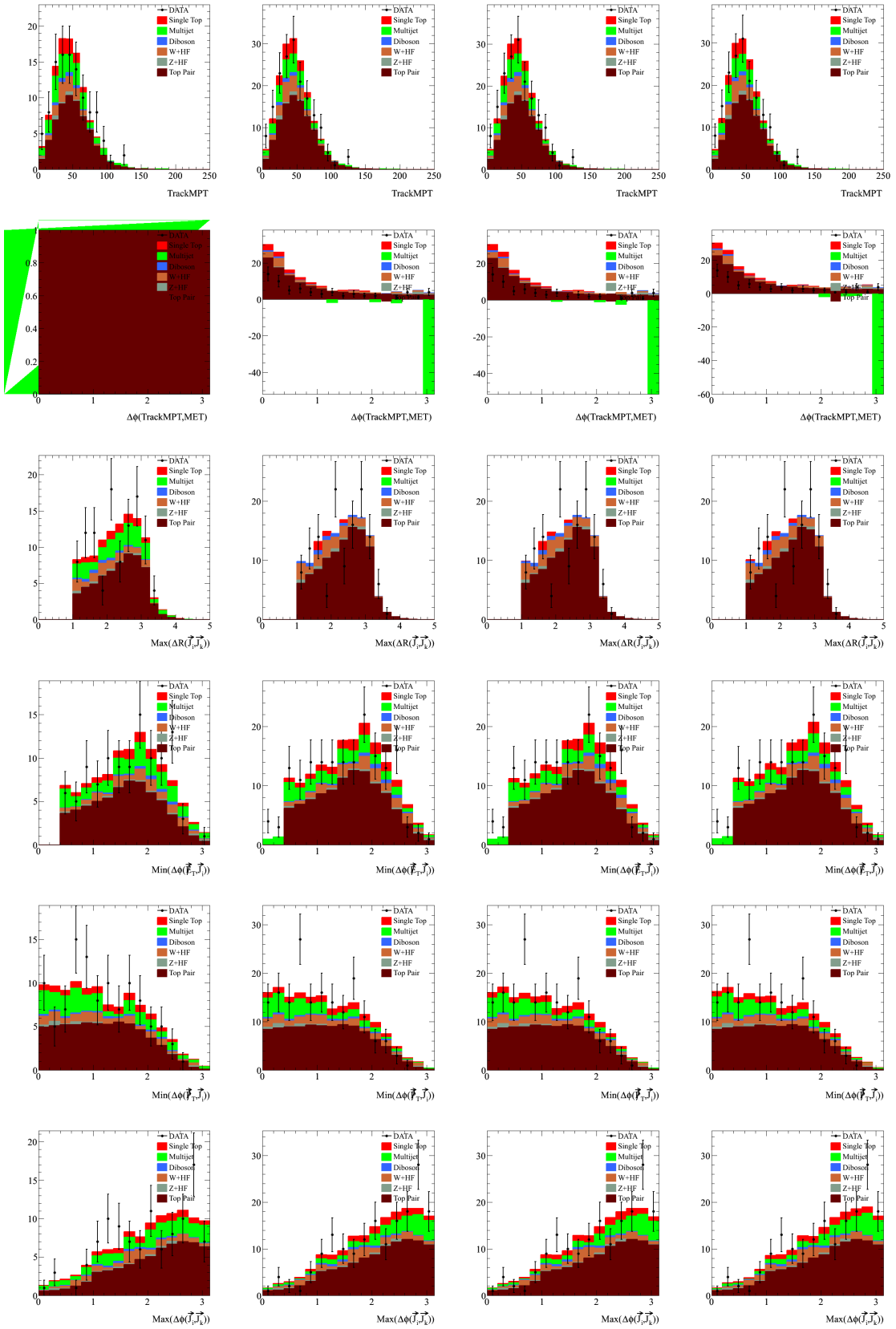

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δϕ(TrackMPT,MET)
Max(ΔR(j,j))
Min(Δϕ(p_T,j))
Max(Δϕ(j,j))

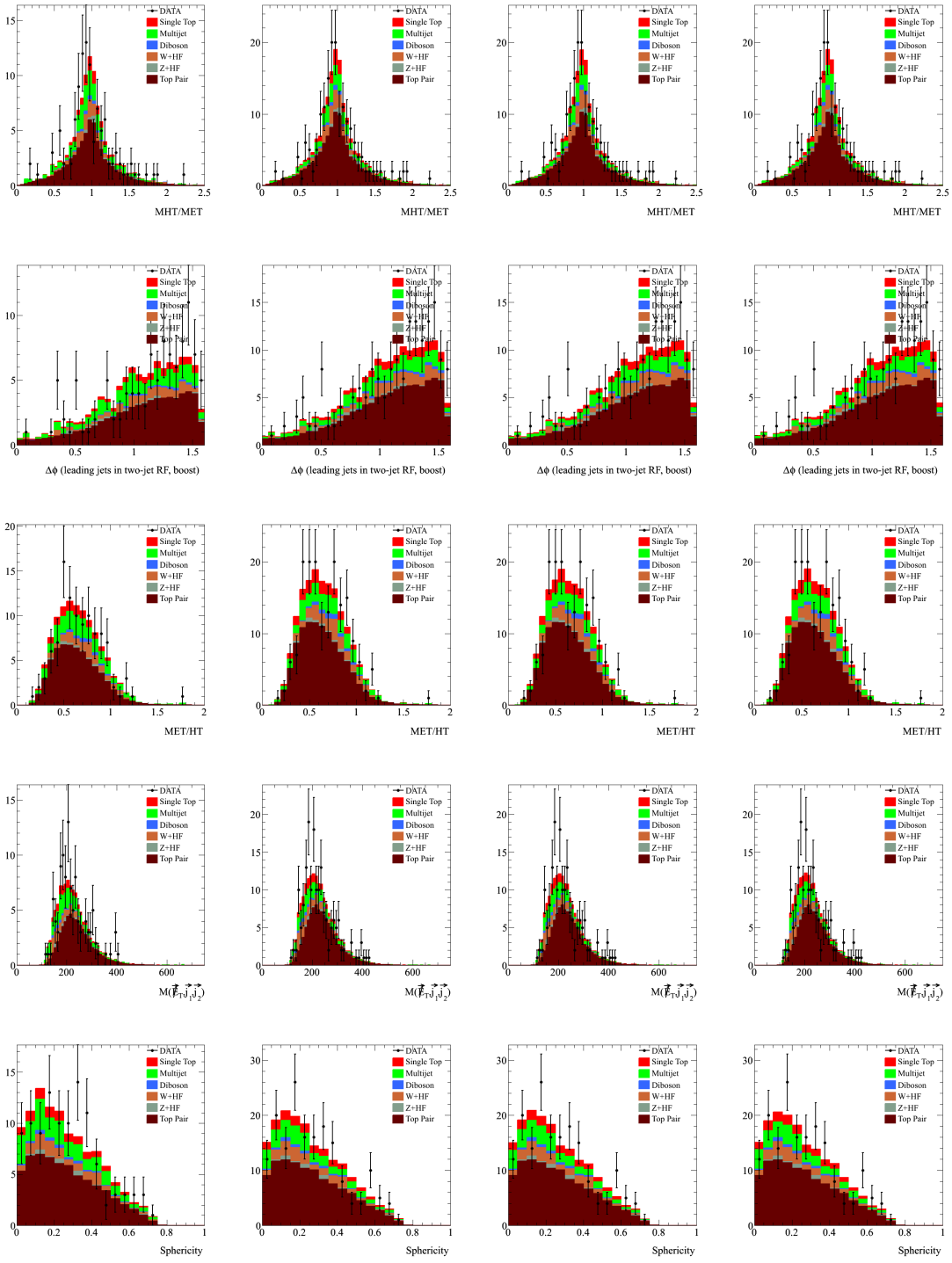

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
M($\vec{\not E}_T \vec{j}_1 \vec{j}_2$)
Sphericity

1.3.3 EwkCR/ region




DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/P_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(j_i,j_k))
Min(Δφ(p_T,j_i))
Max(Δφ(j_i,j_k))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
M($\vec{p}_{T,j_1}\vec{p}_{T,j_2}\vec{d}_{j_1}\vec{d}_{j_2}$)
Sphericity

1.4 Summary on these 4 "old" approaches

- There is no significant difference by applying the existed method with higher luminosities, though with larger data set we can have larger matrix.
- Smaller bins on J1(2)Z did improve its own distribution, but negligible effects on the others.
- From the mjj distribution in different regions, we can see slightly the bias: i.e., jet in TRM tends to have smaller Et, which predicts smaller mjj in the other regions.

2 Methods with new parameters

Motivation of this section mainly comes from the various approaches for TRM has been used by different groups in CDF. In this section, the data refers to 3.6fb^{-1} unless specified.

- base: "old TRM" derived with 3.6fb^{-1}, then applies to 3.6fb^{-1}. For comparison purpose.
- try2:

J1(2)Et	25	50	80	100	120	150	200	1000				
J1(2)$\lvert\eta\rvert$	0.0	0.4	0.8	2.0								
J1(2)Ntrk	0	2	3	4	5	6	7	8	9	11	13	100

- try3:

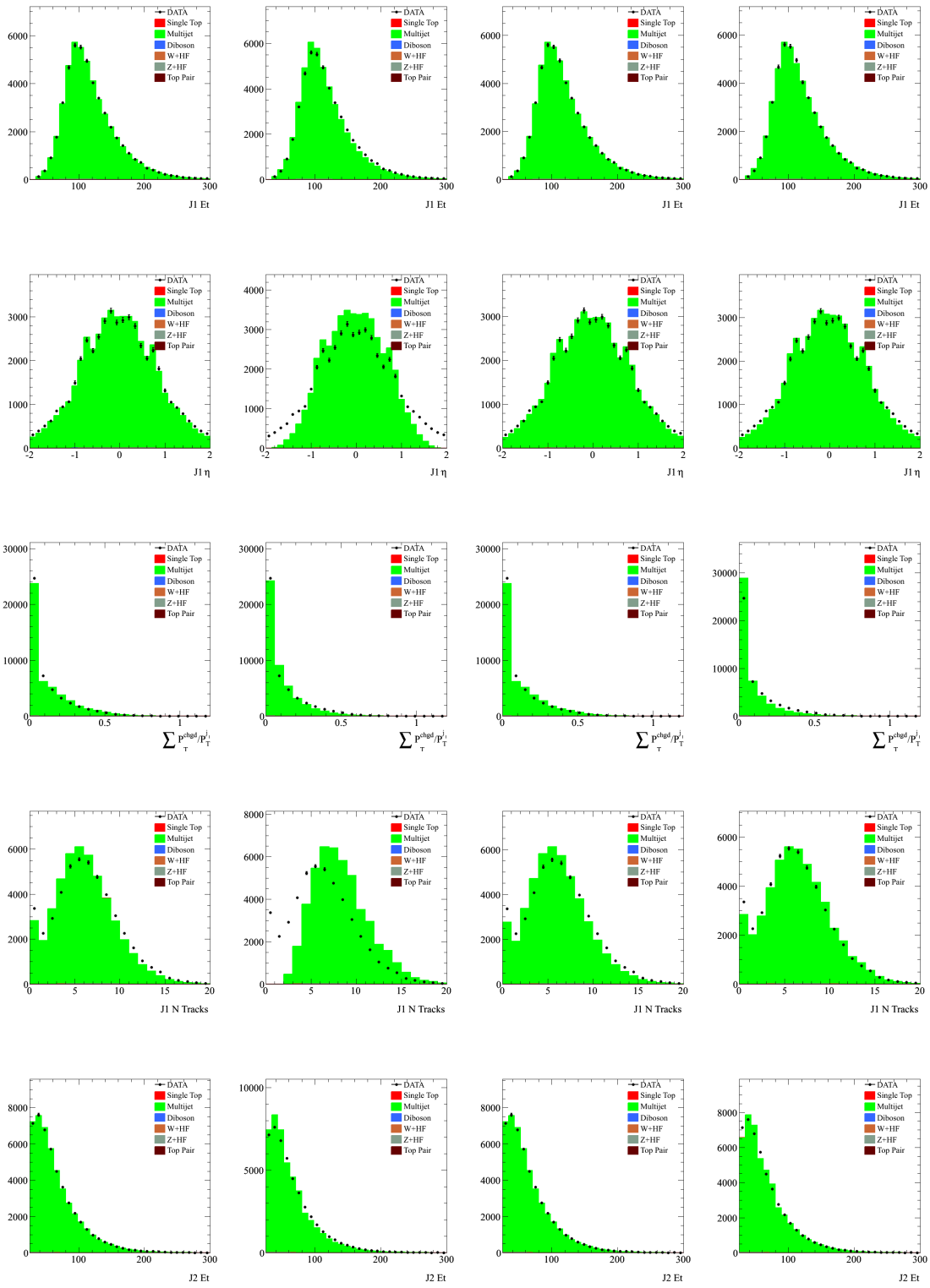
J1(2)Et	25	50	80	100	120	150	200	1000
Jiϕ^1	0.0	$\frac{1}{4}\pi$	$\frac{1}{2}\pi$	$\frac{3}{4}\pi$	π			
HT3	60	150	350	1000				
J1(2)Z	0.0	0.1	0.2	0.4	0.8	10.		

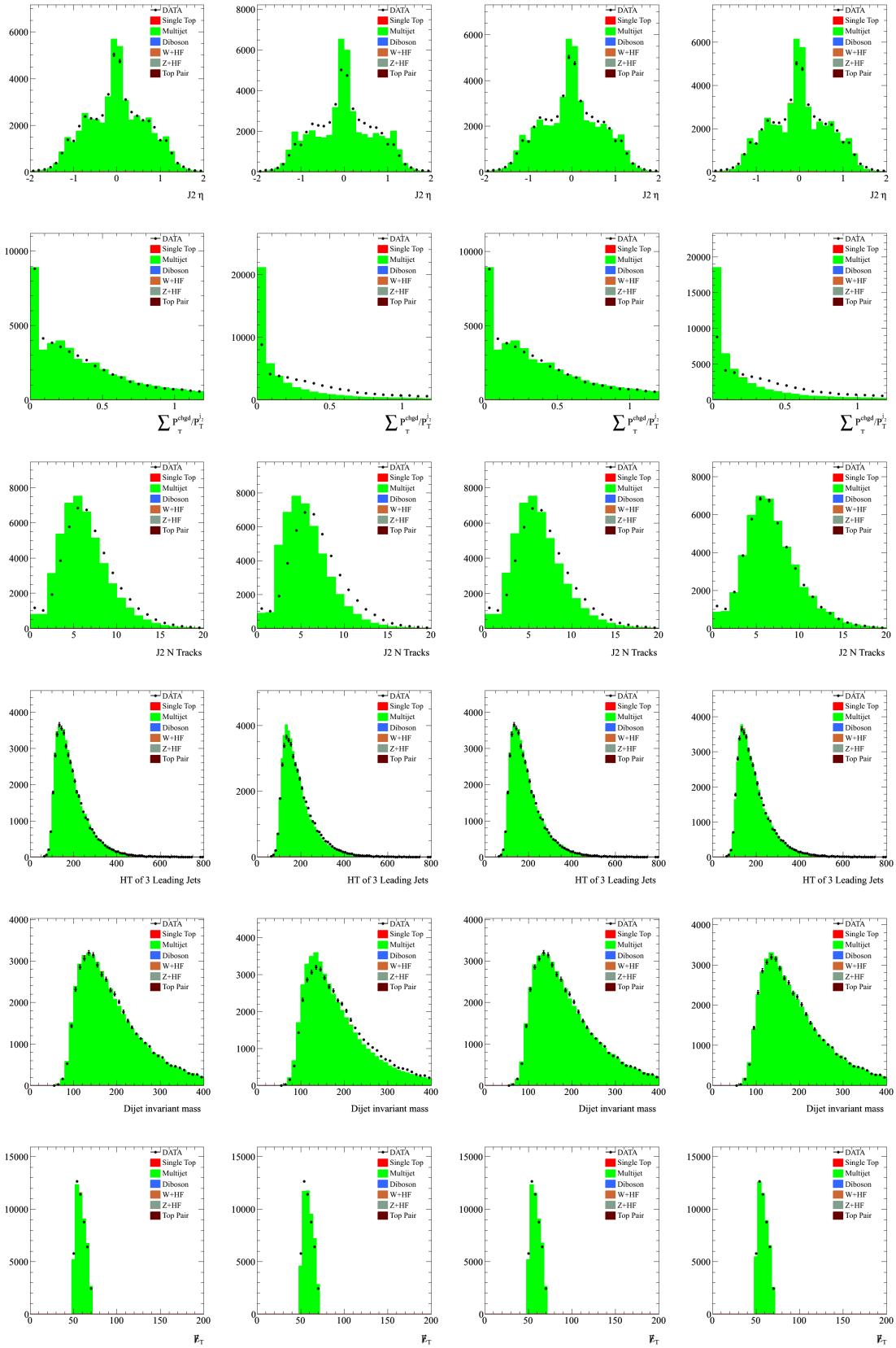
- try4:

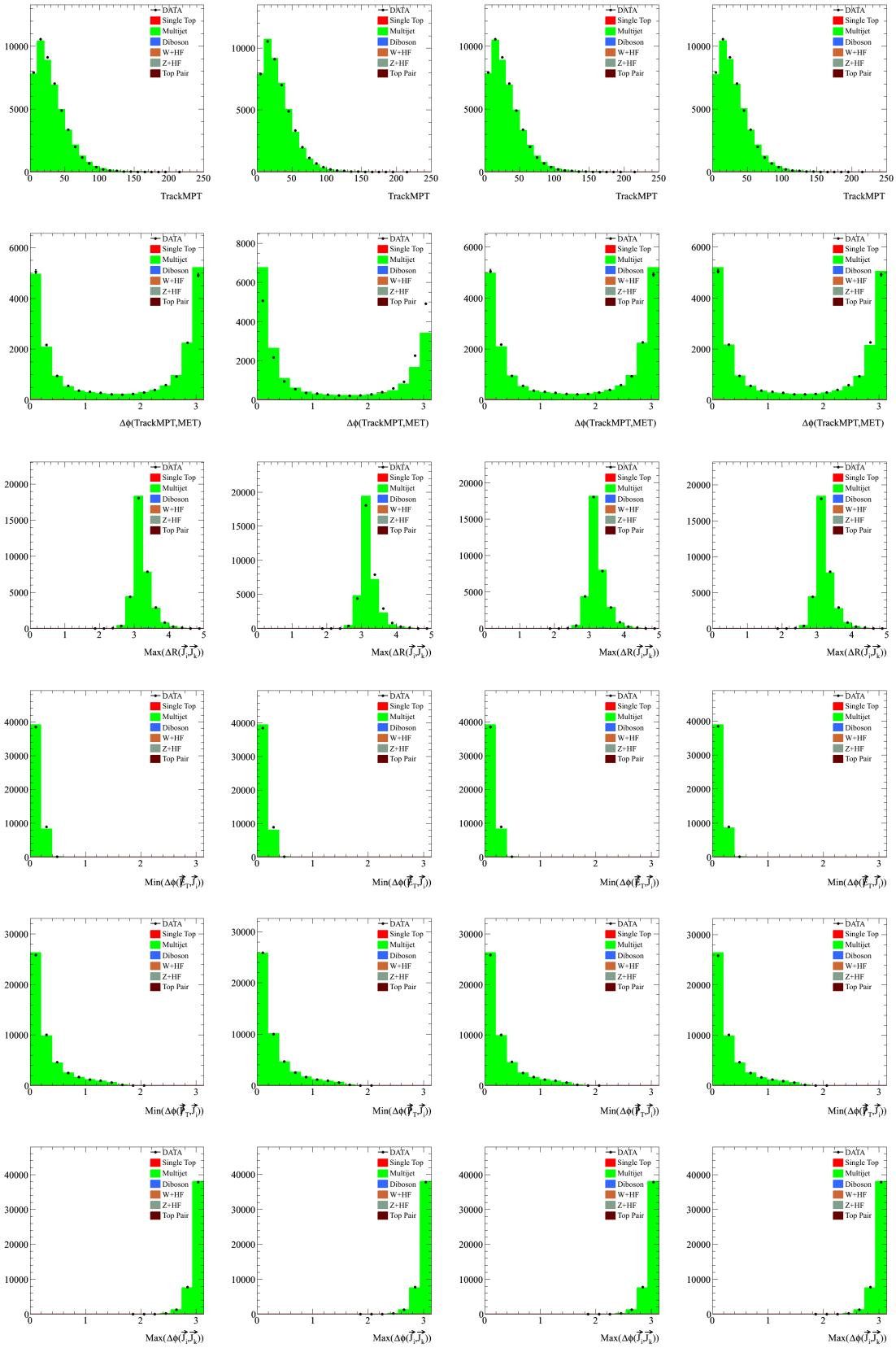
J1(2)Et	25	50	80	100	120	150	200	1000				
J1(2)$\lvert\eta\rvert$	0.0	0.4	0.8	2.0								
HT3	60	150	350	1000								
J1(2)Ntrk	0	2	3	4	5	6	7	8	9	11	13	100
J1(2)ϕ	0.0	$\frac{1}{4}\pi$	$\frac{1}{2}\pi$	$\frac{3}{4}\pi$	π							

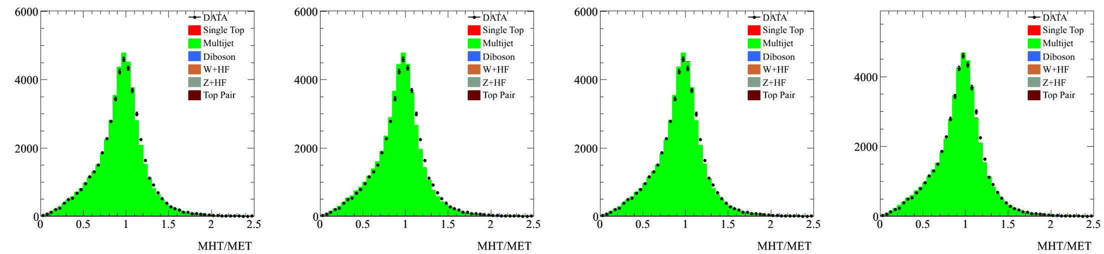
2.1 Category: 1S (plots are in order of 4 approaches)

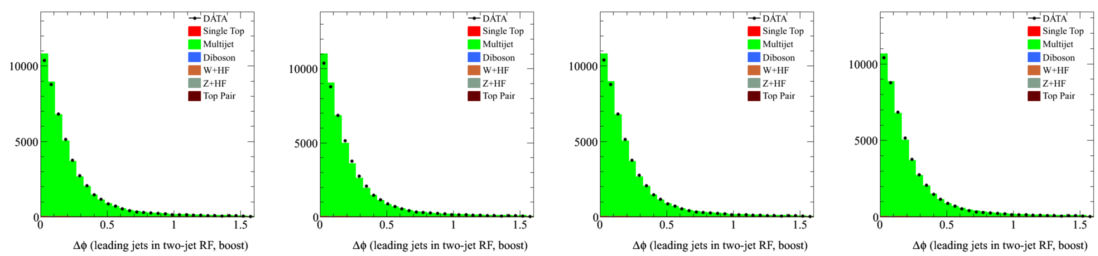
2.1.1 TRM/ region

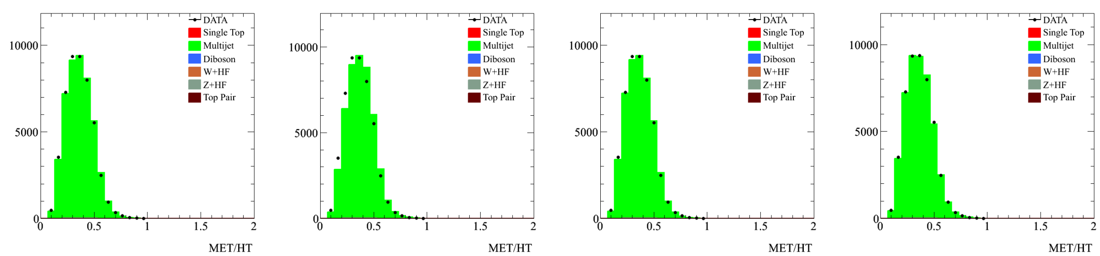


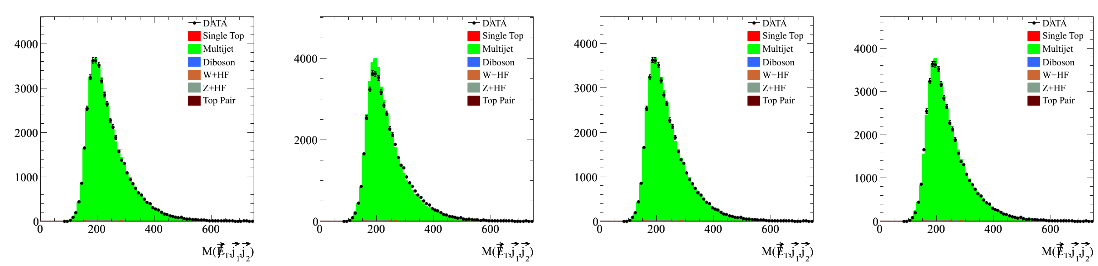

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

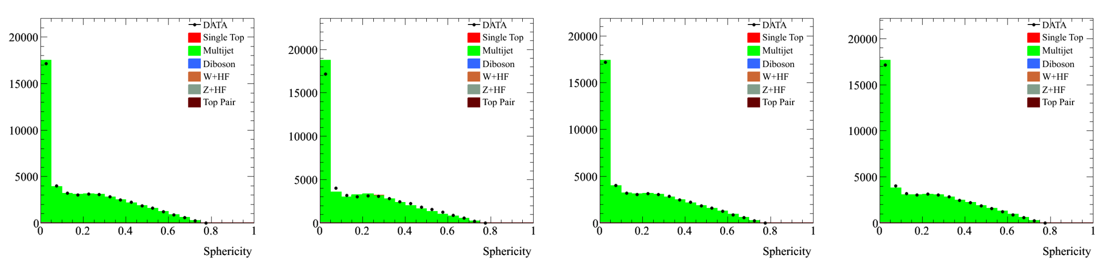

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET

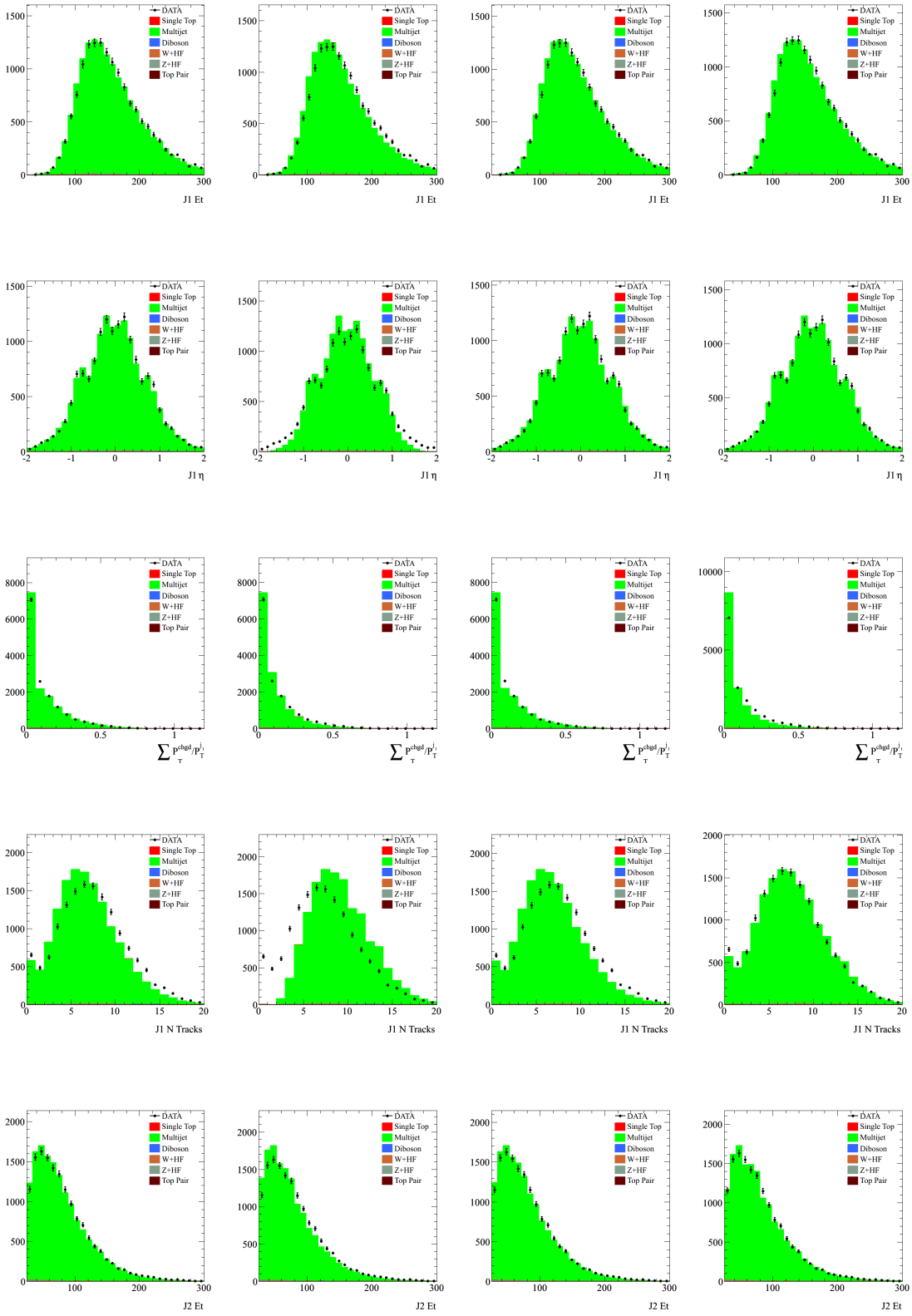

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Δϕ (leading jets in two-jet RF, boost)

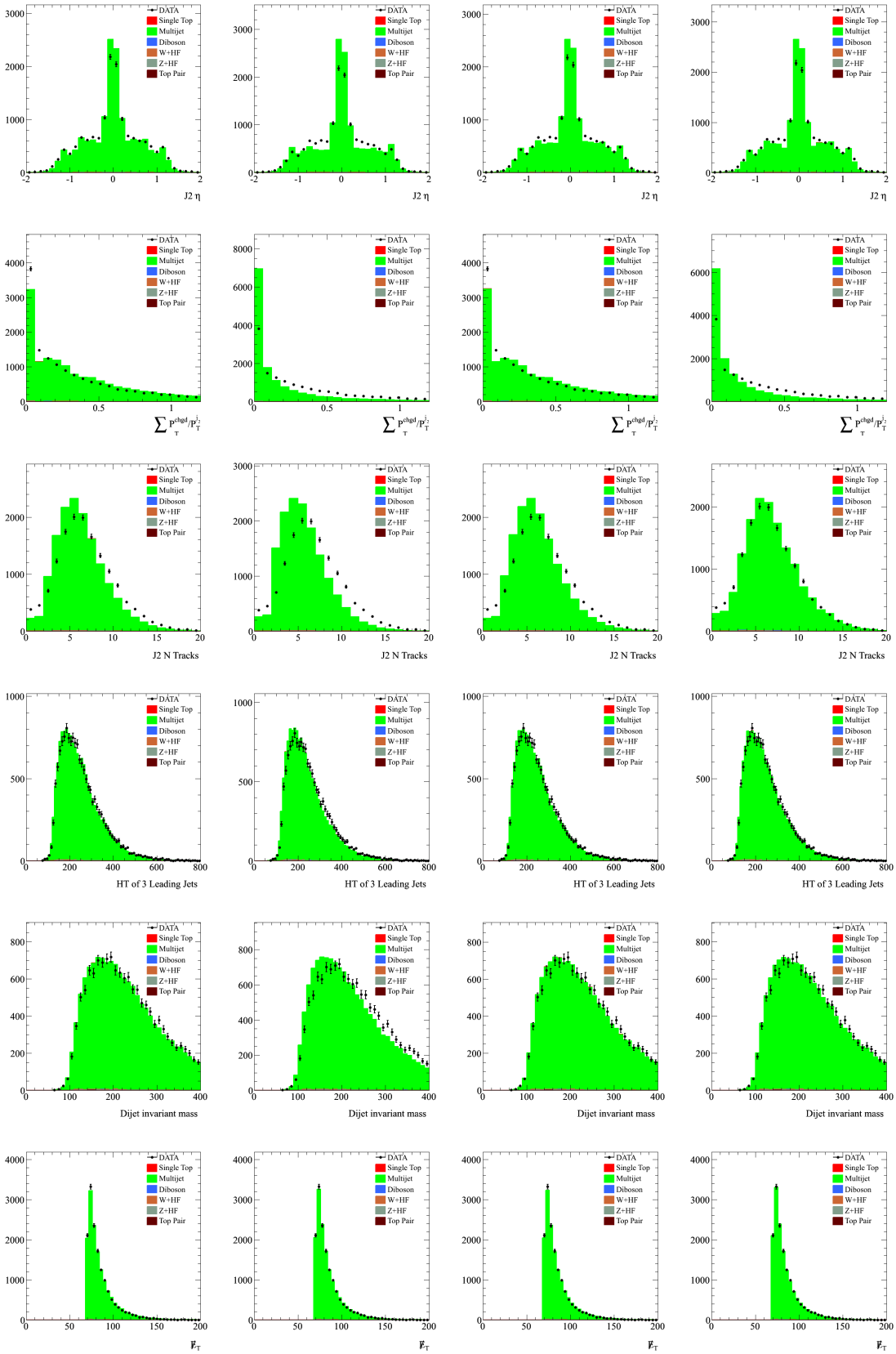

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MET/HT

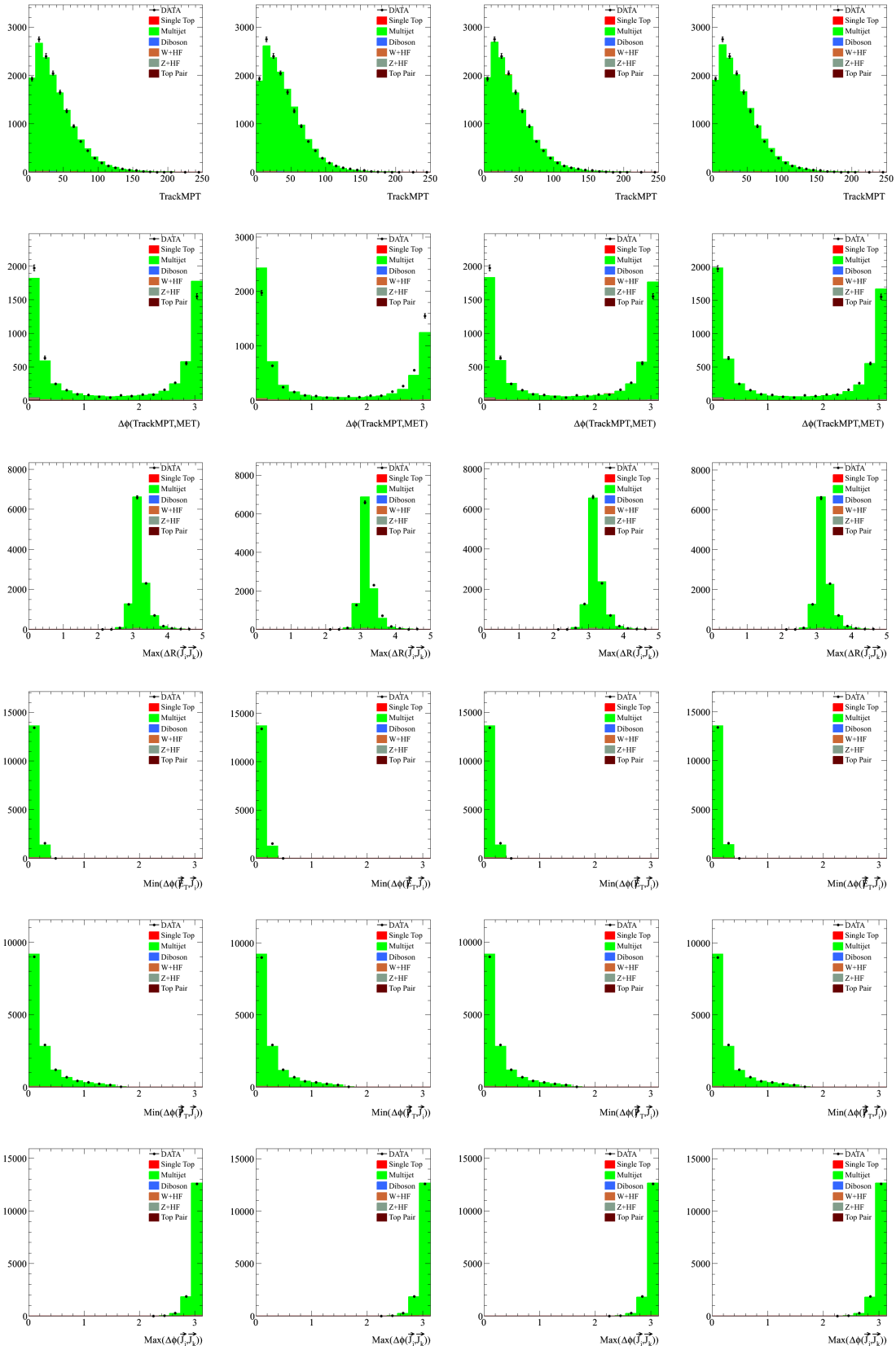

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair

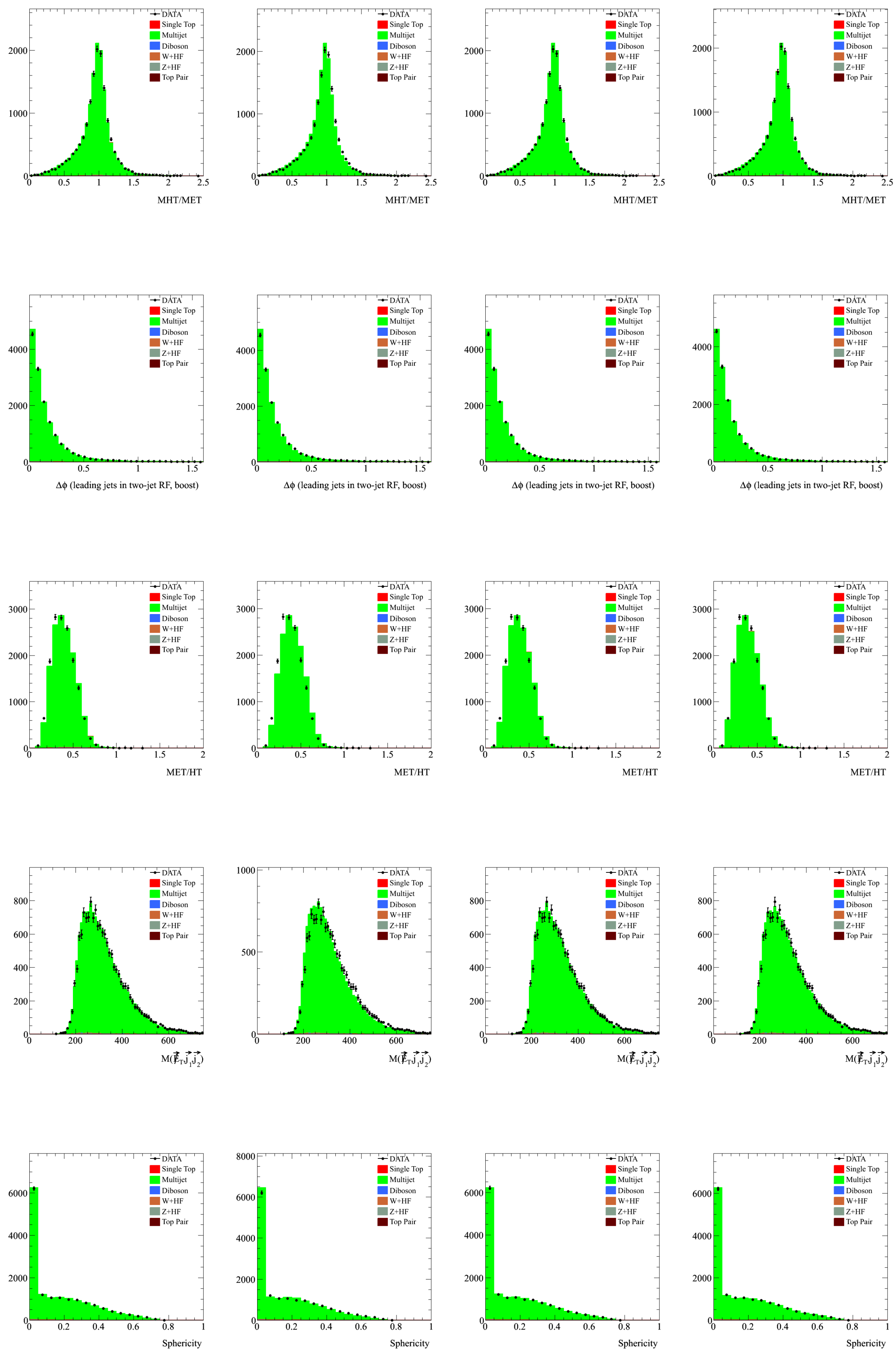

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Sphericity

2.1.2 QCDCR/ region

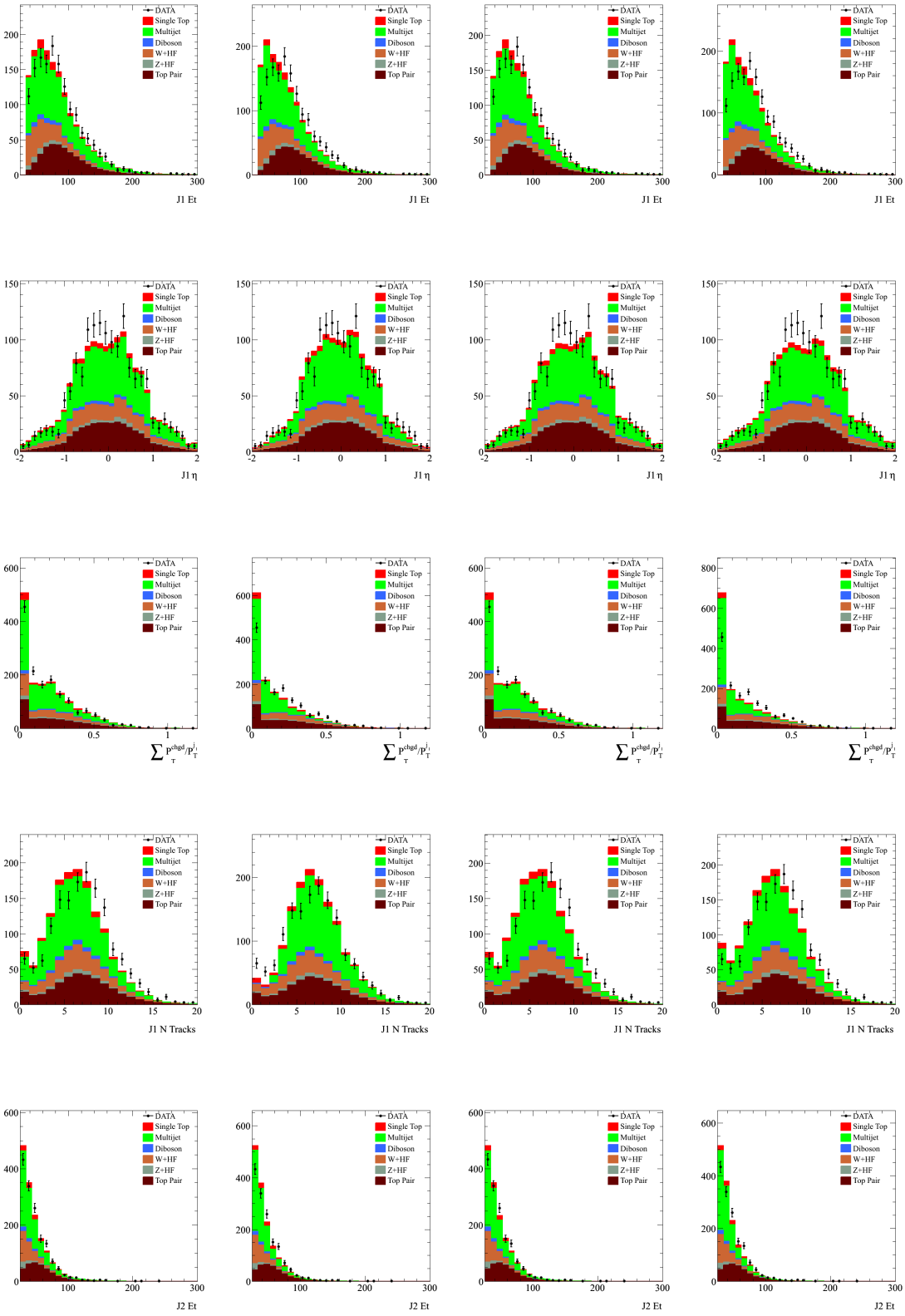


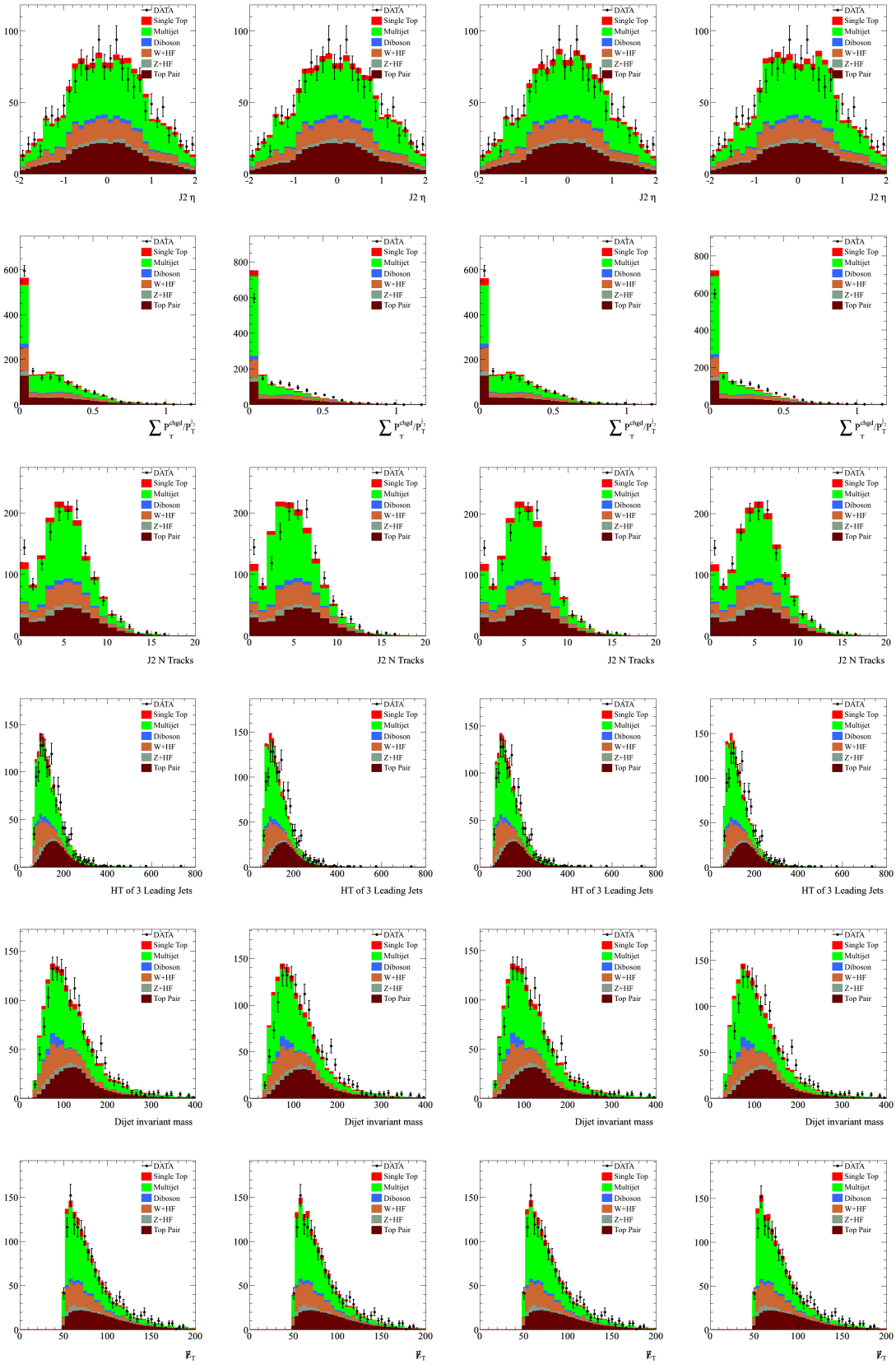

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

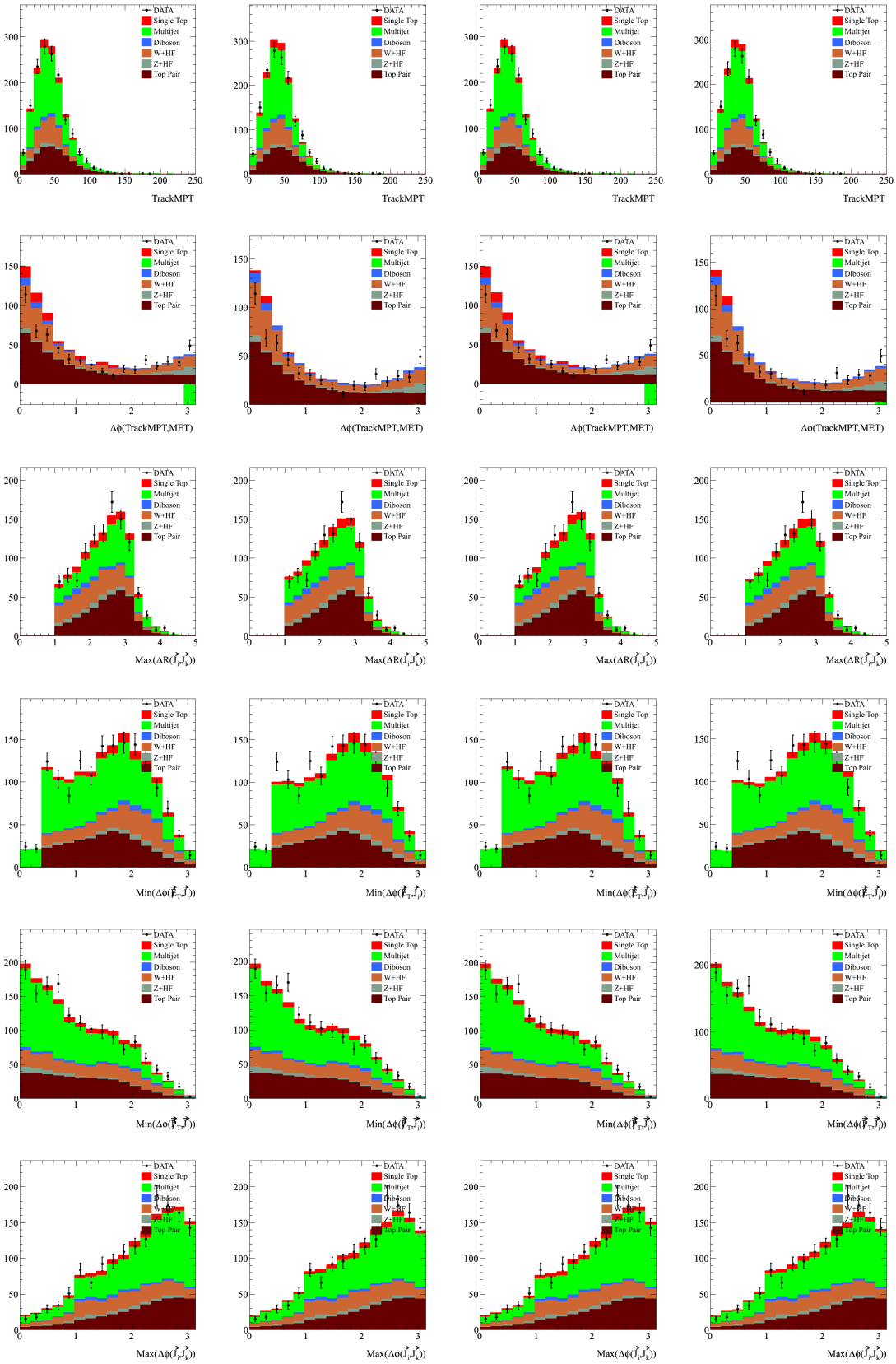

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))

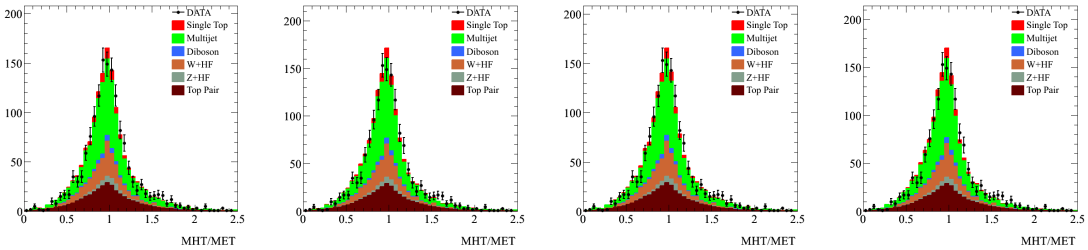

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
$M(\not{E}_T \vec{j}_1 \vec{j}_2)$
Sphericity

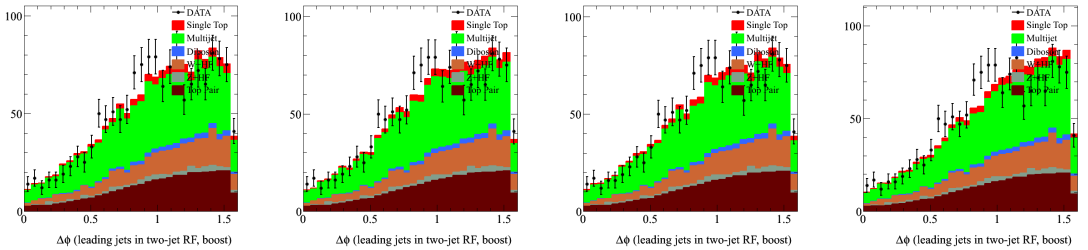
2.1.3 EwkCR/ region

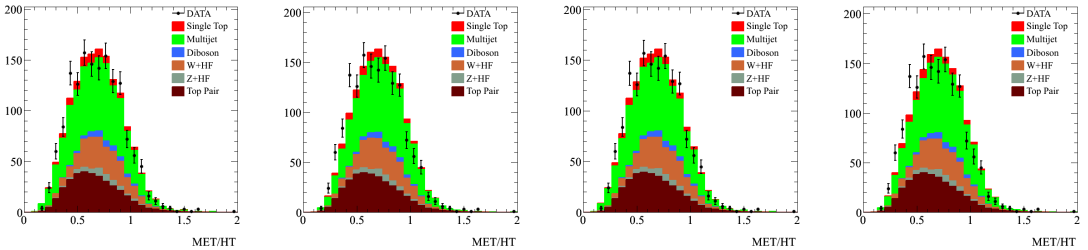


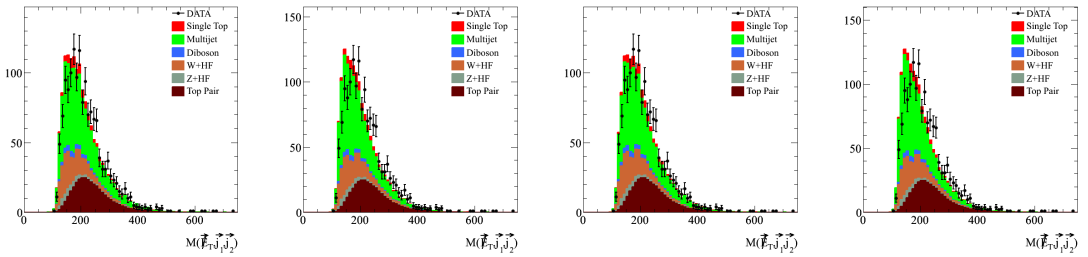

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

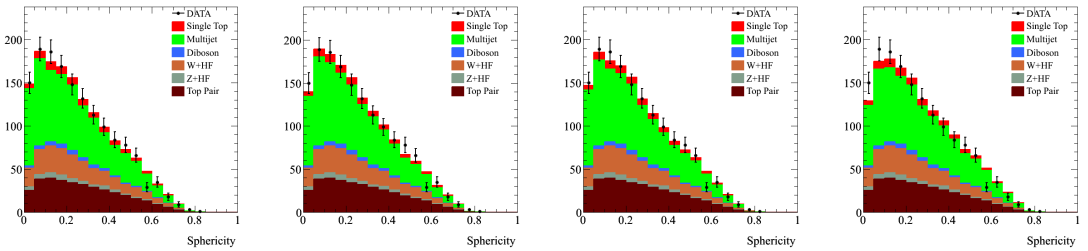

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Δϕ (leading jets in two-jet RF, boost)

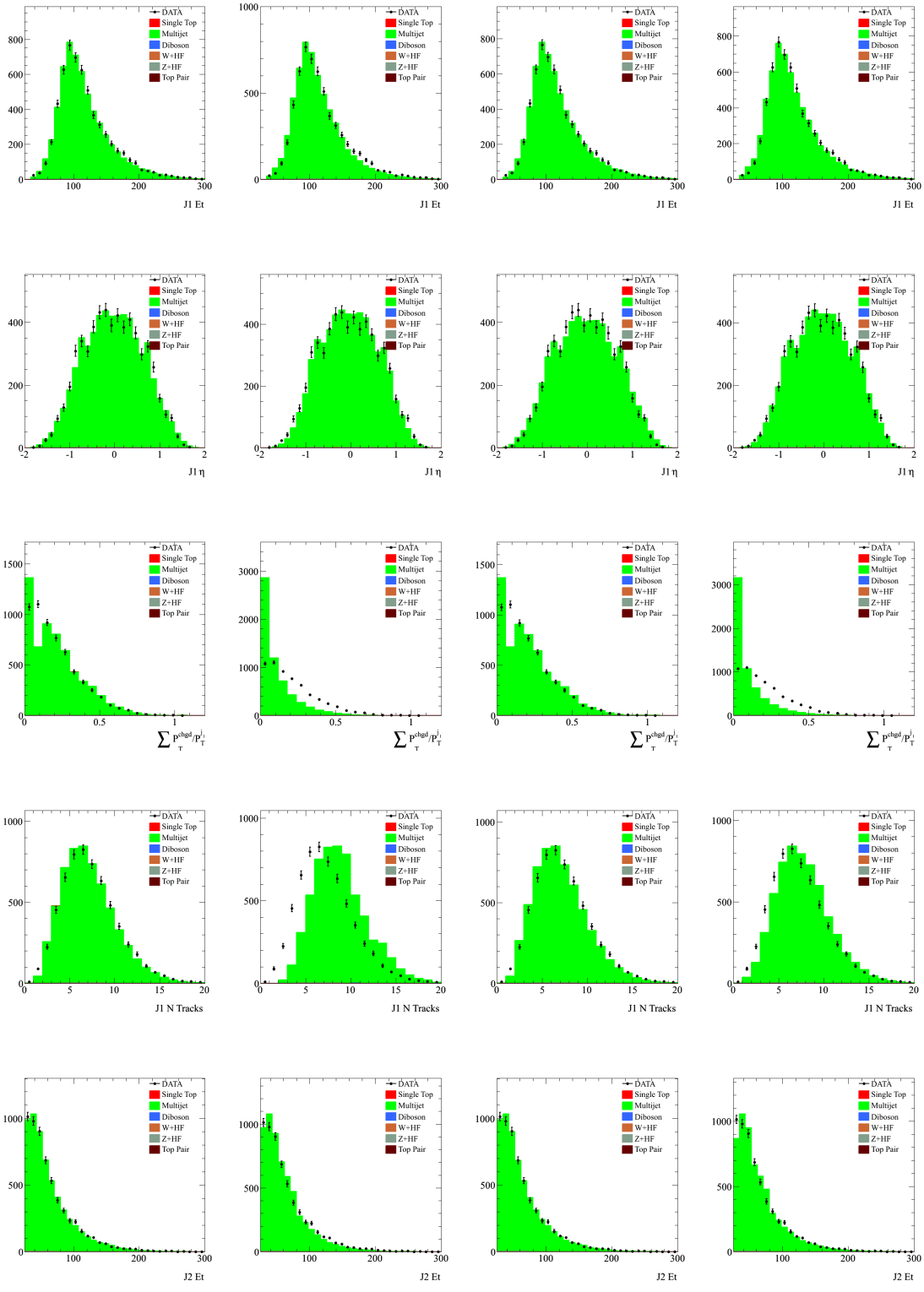

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MET/HT

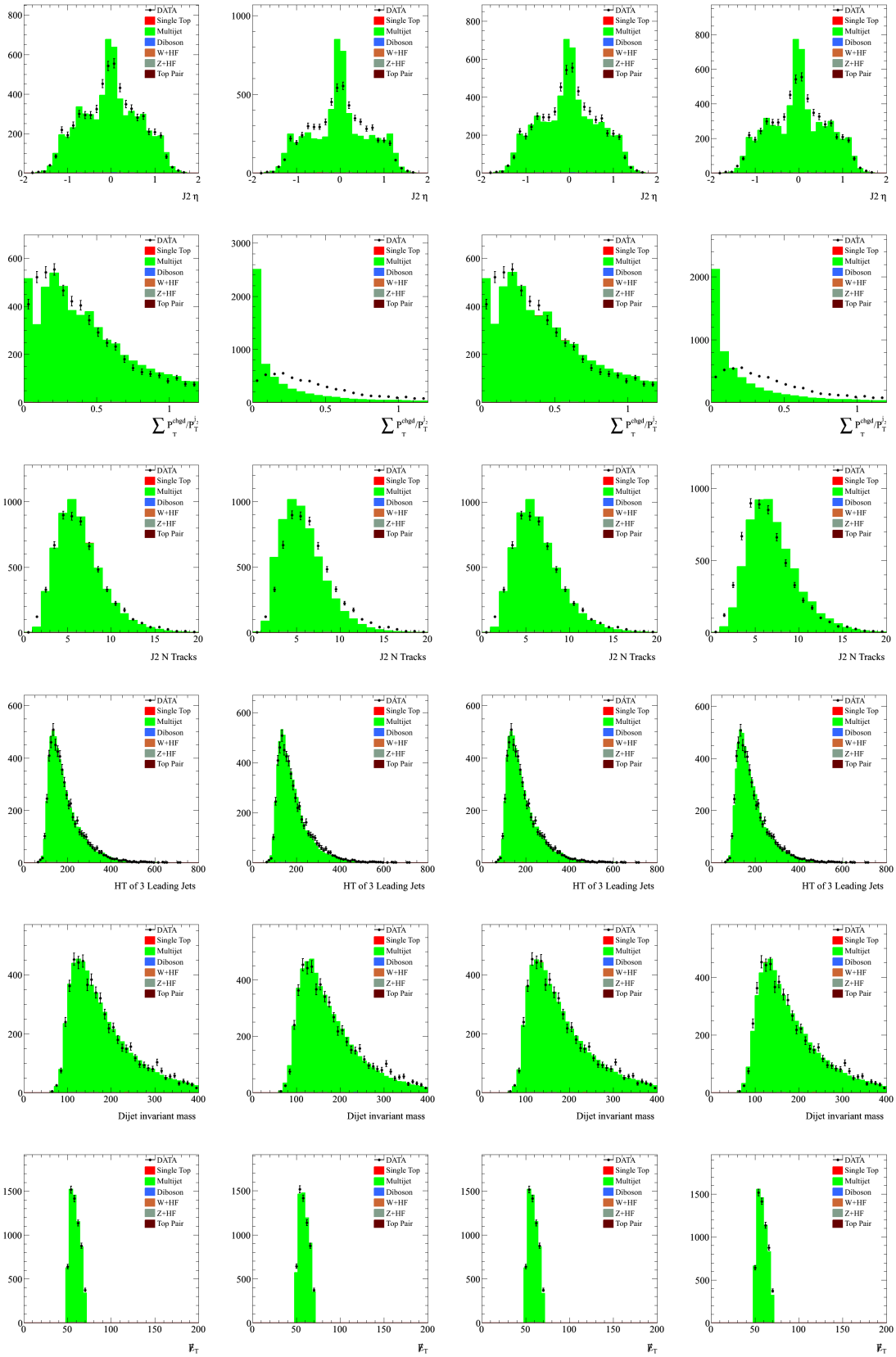

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair

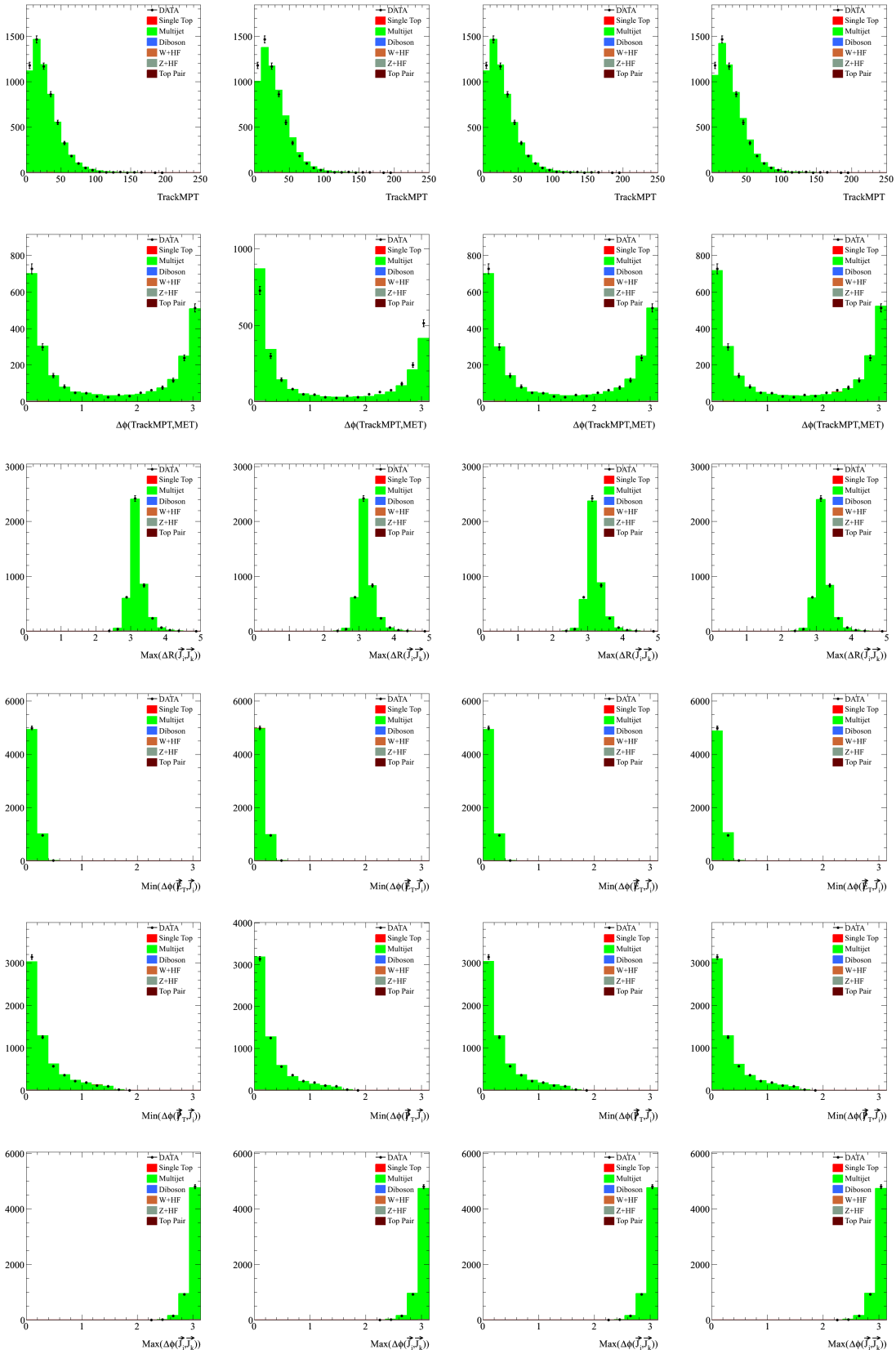

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Sphericity

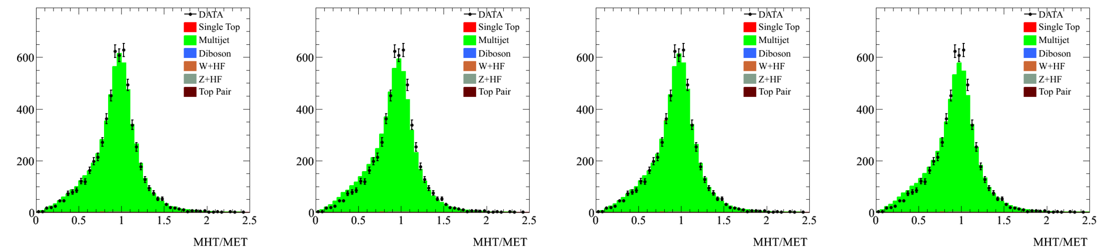
2.2 Category: SJ (plots are in order of 4 approaches)

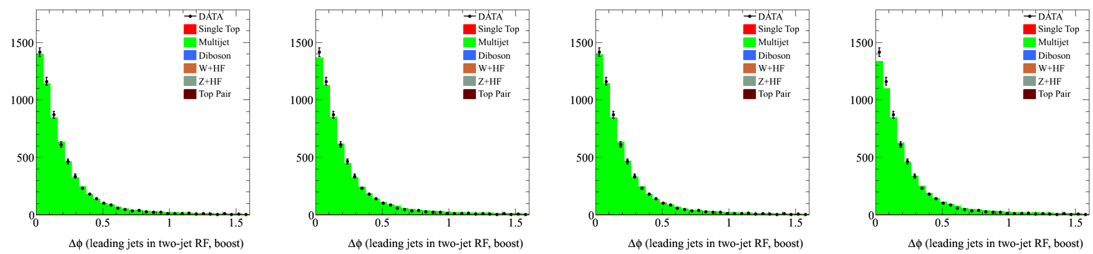
2.2.1 TRM/ region

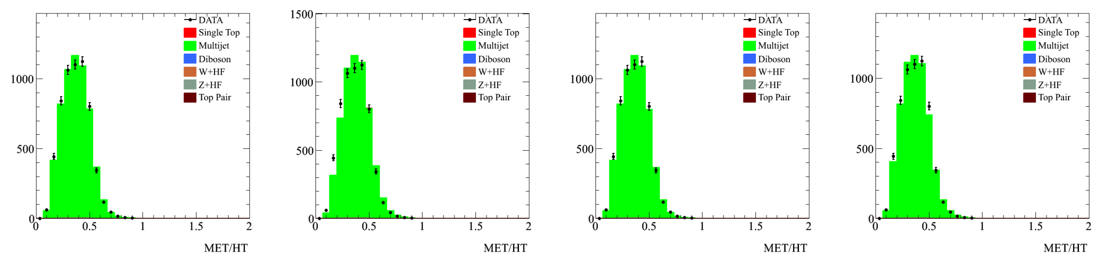


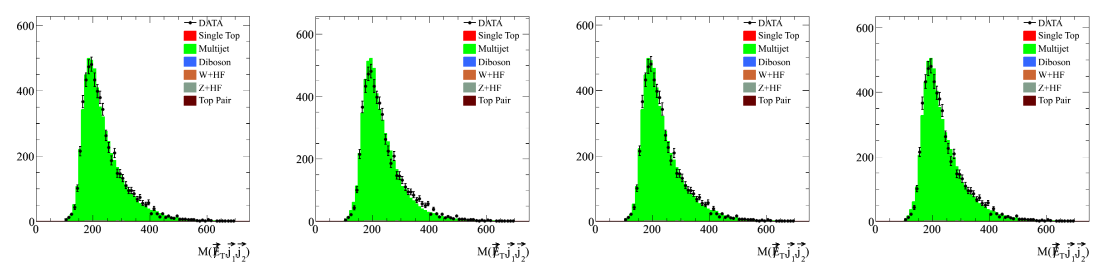

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

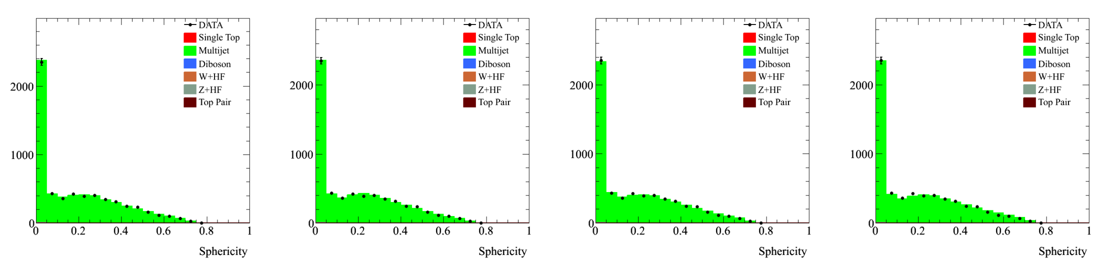

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(j,j))
Min(Δφ(p_T,j))
Max(Δφ(j,j))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET

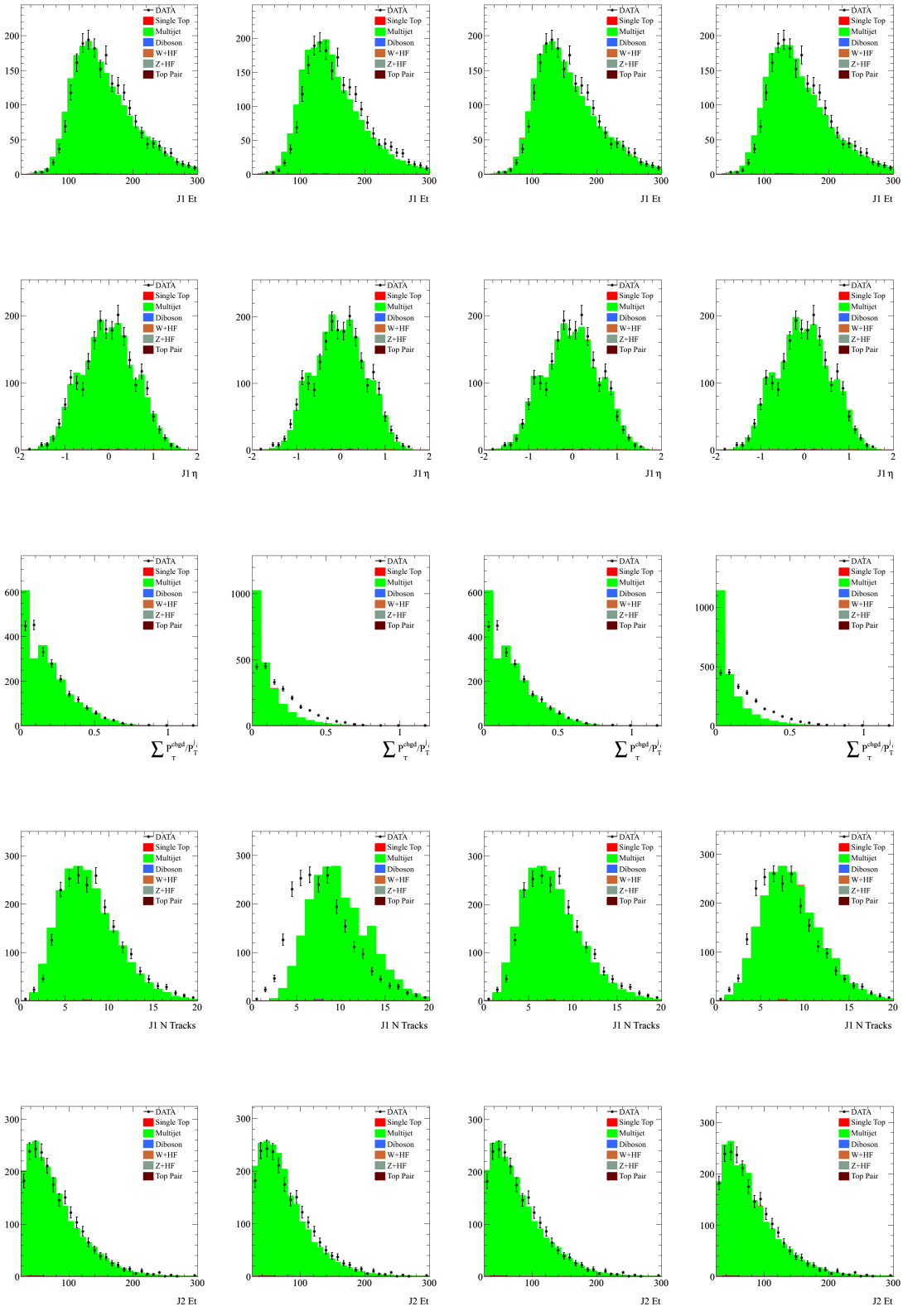

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Δϕ (leading jets in two-jet RF, boost)

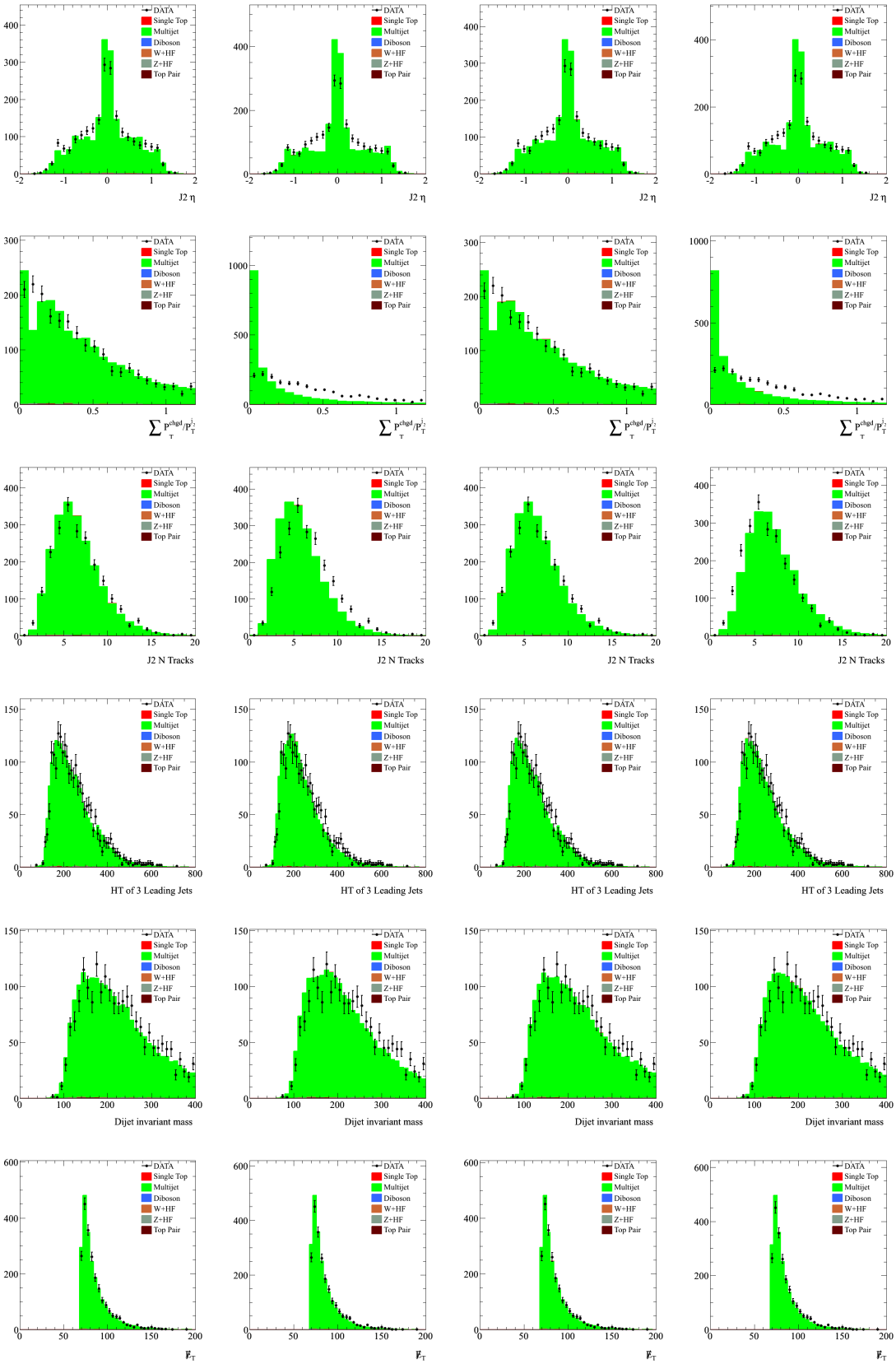

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MET/HT

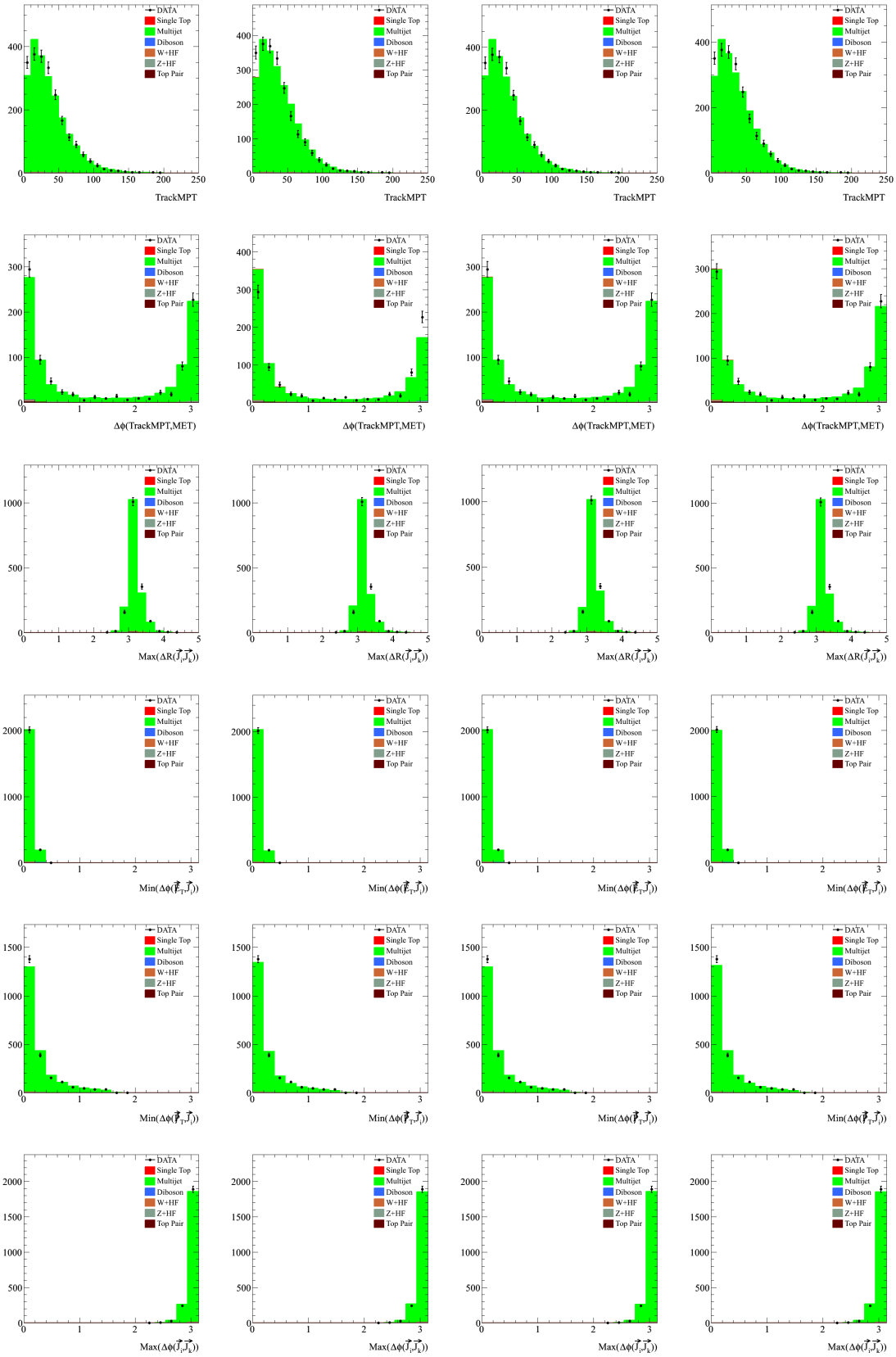

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair

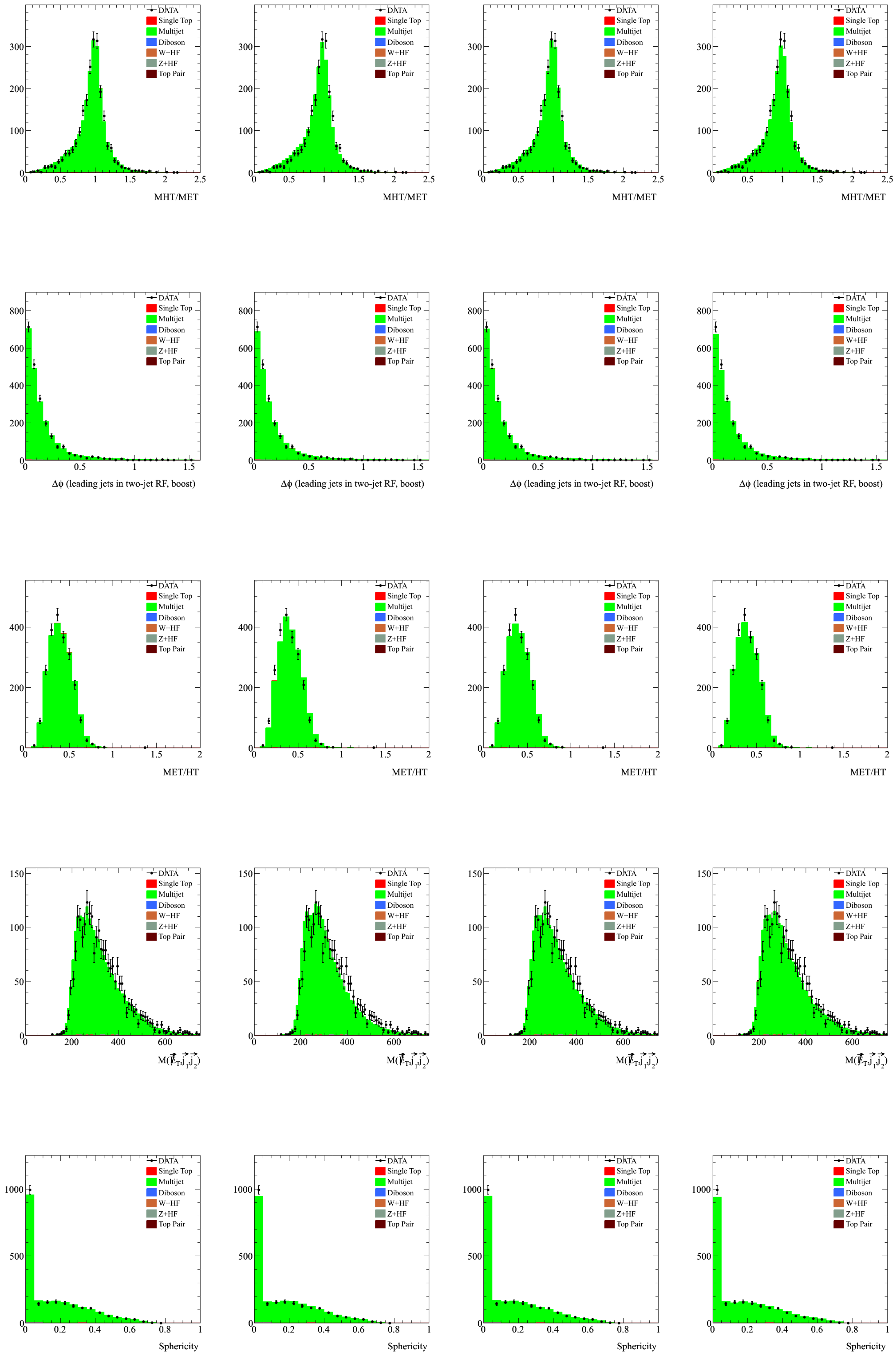

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Sphericity

2.2.2 QCDCR/ region

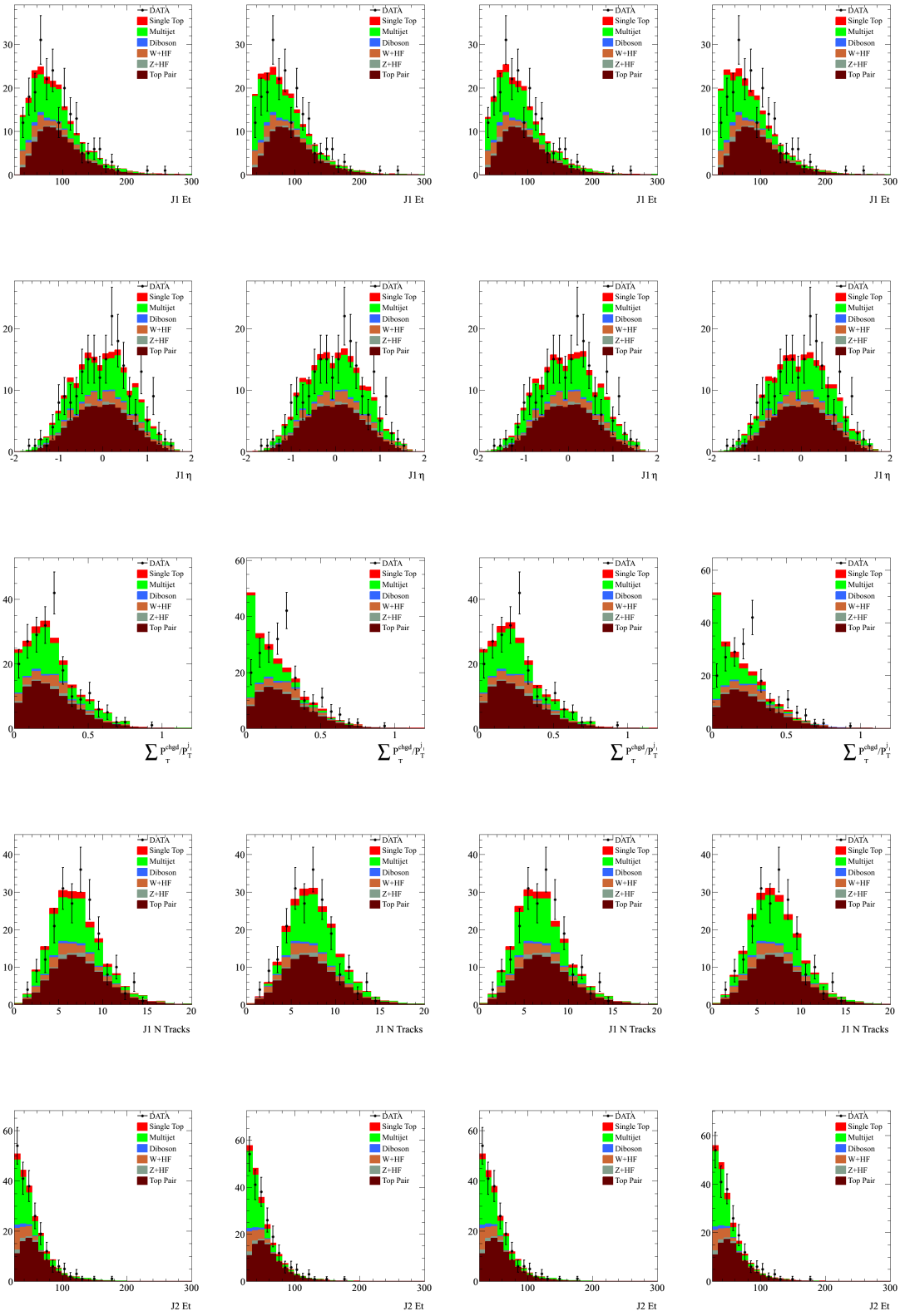


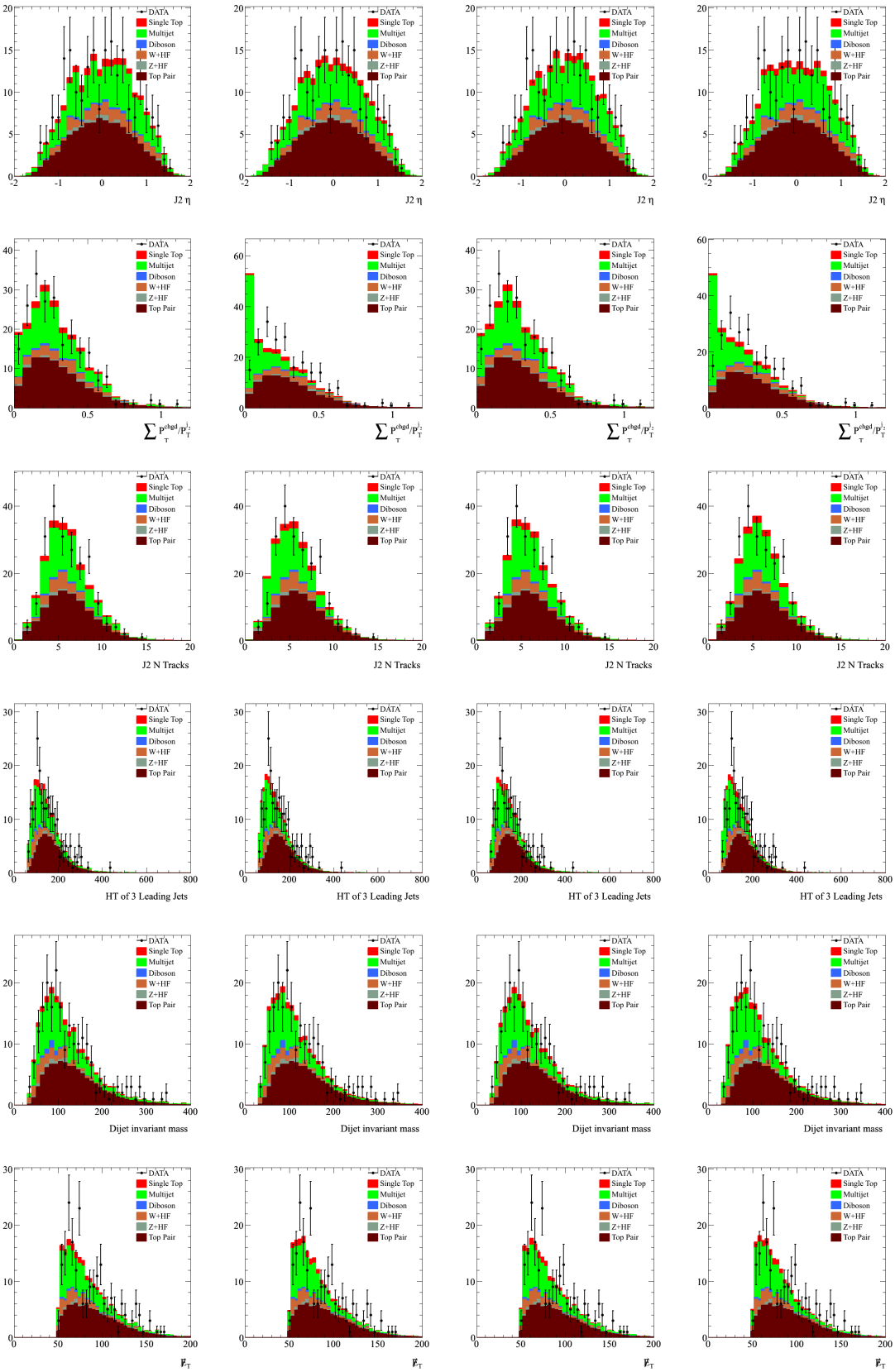

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

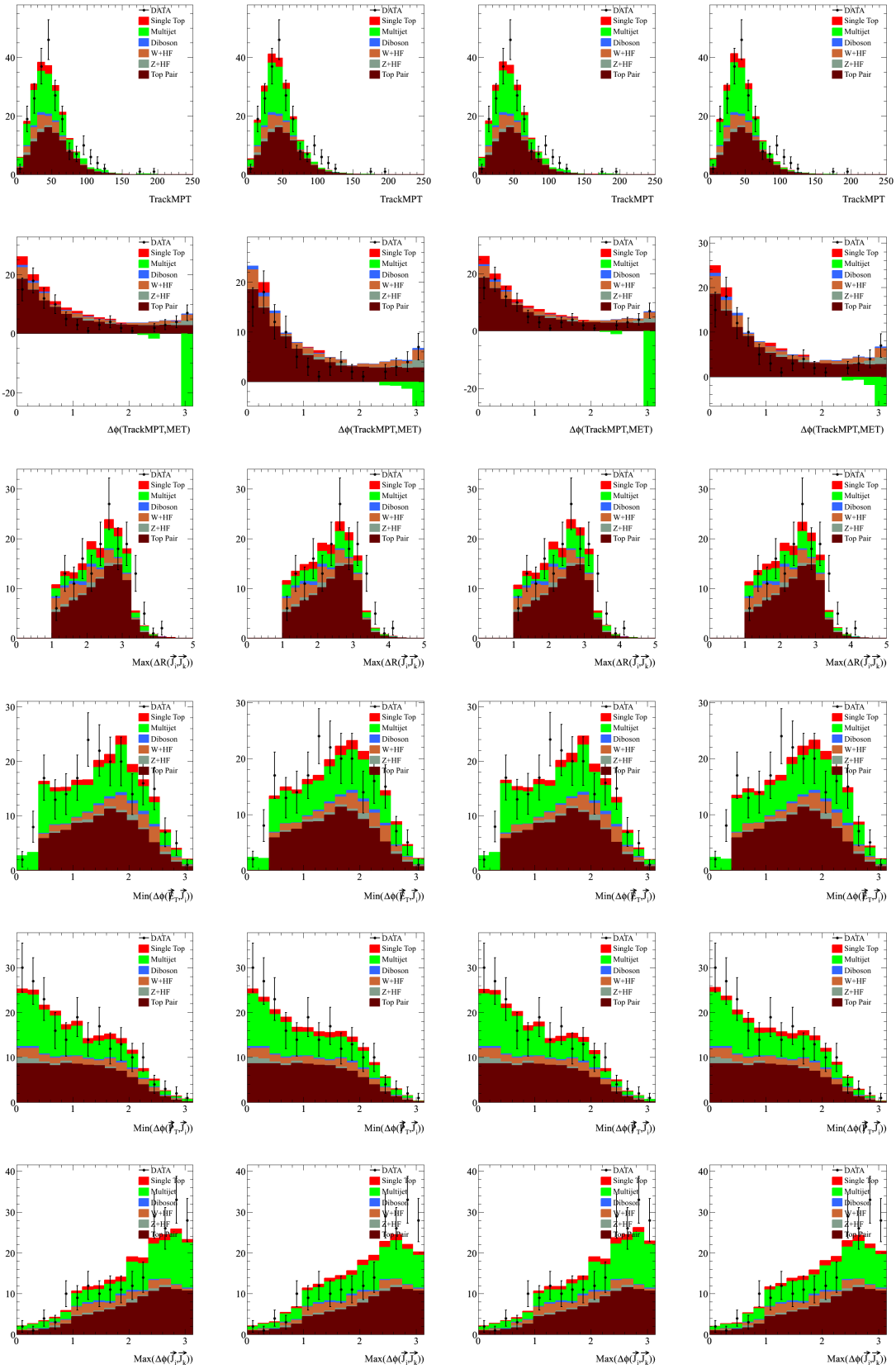

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))

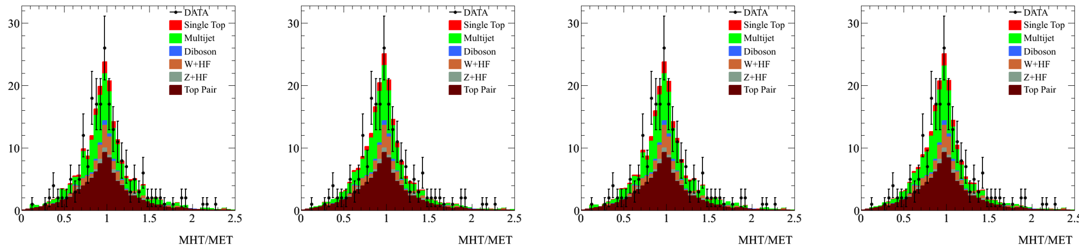

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
M($\vec{\not E}_T\vec{j}_1\vec{j}_2$)
Sphericity

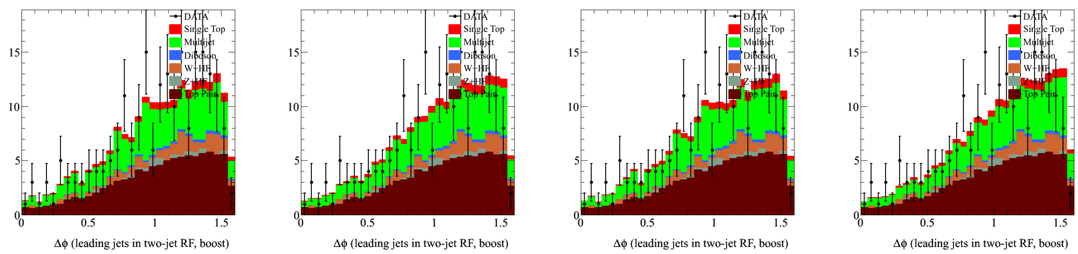
2.2.3 EwkCR/ region

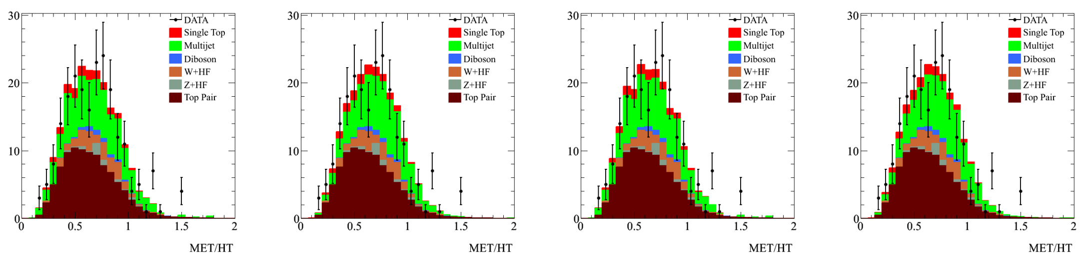


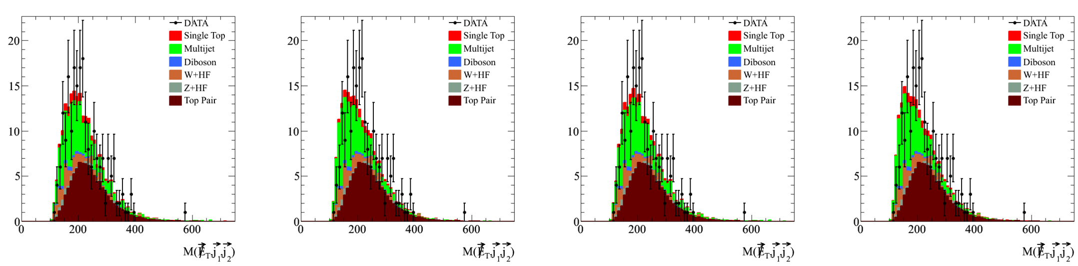

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/P_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

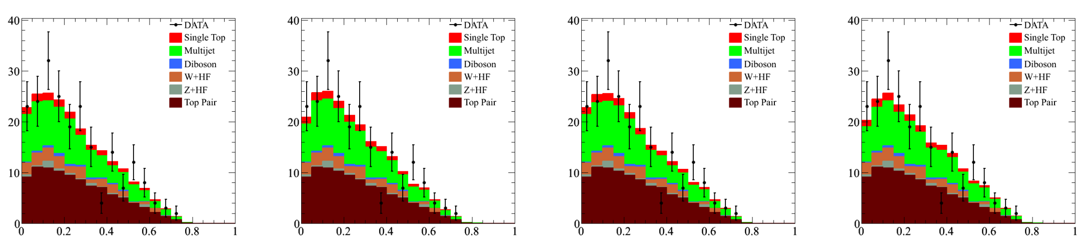

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Δφ (leading jets in two-jet RF, boost)

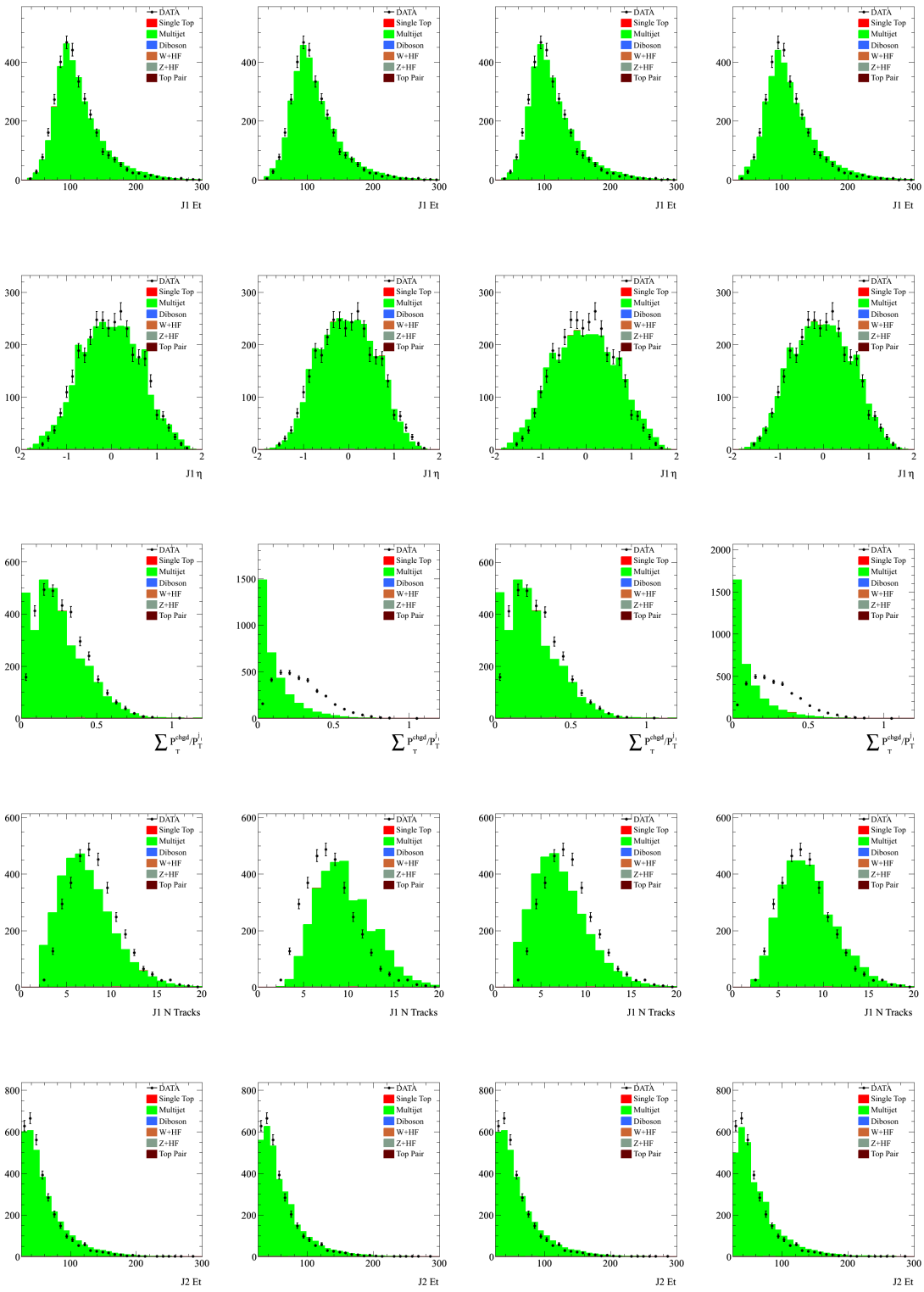

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MET/HT

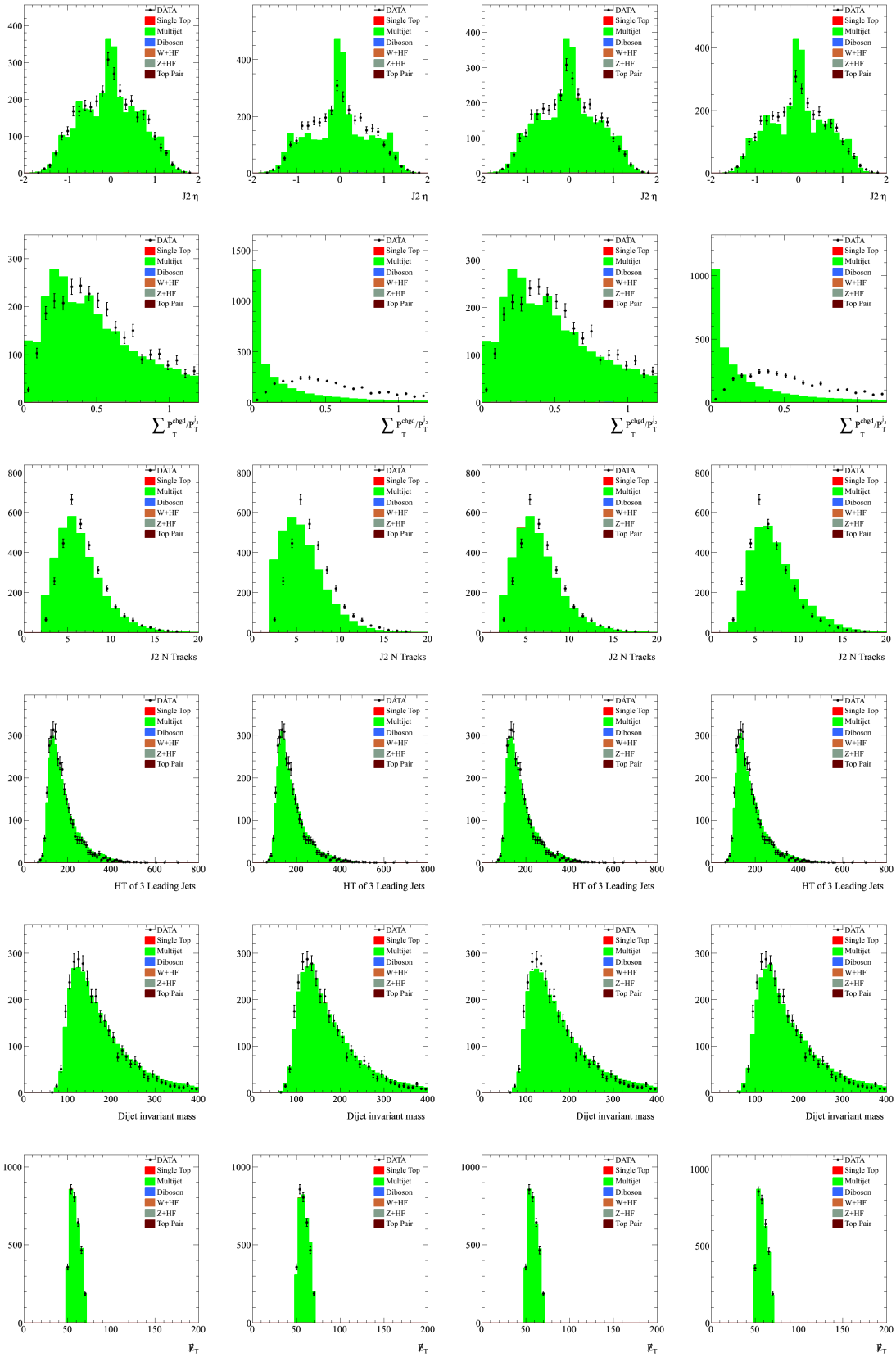

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair

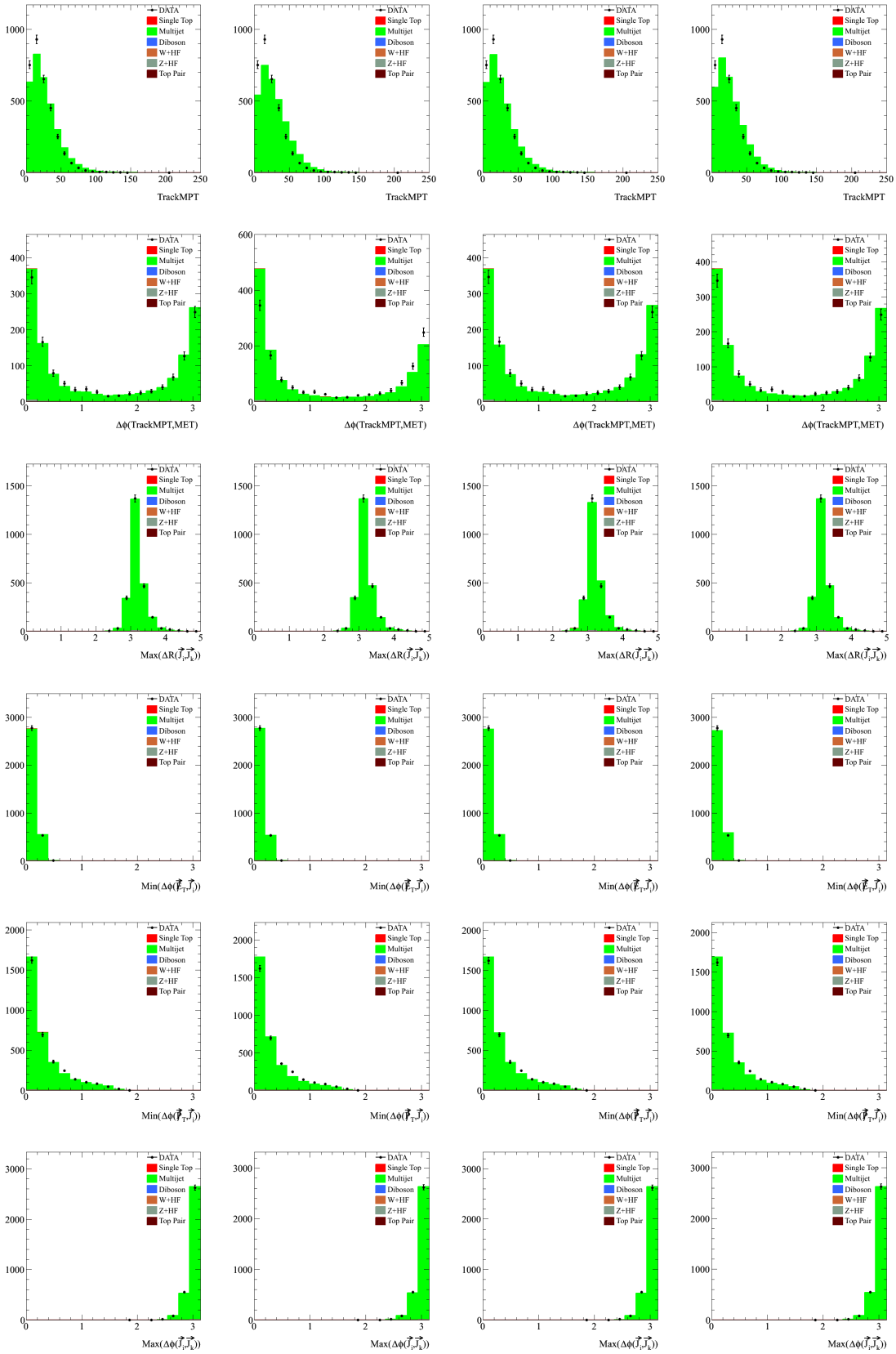

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Sphericity

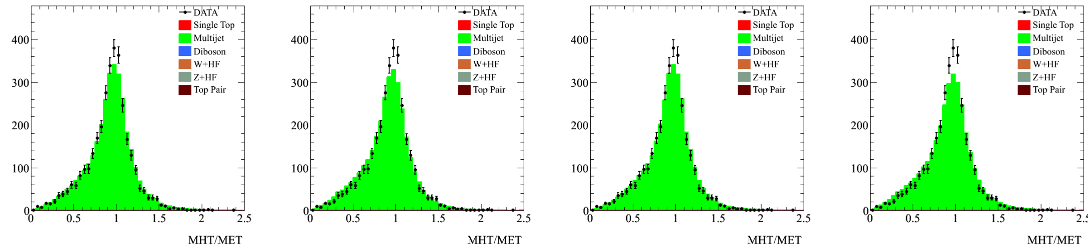
2.3 Category: SS (plots are in order of 4 approaches)

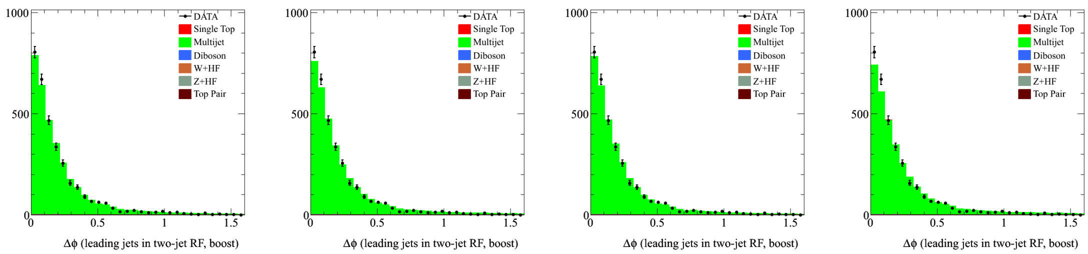
2.3.1 TRM/ region

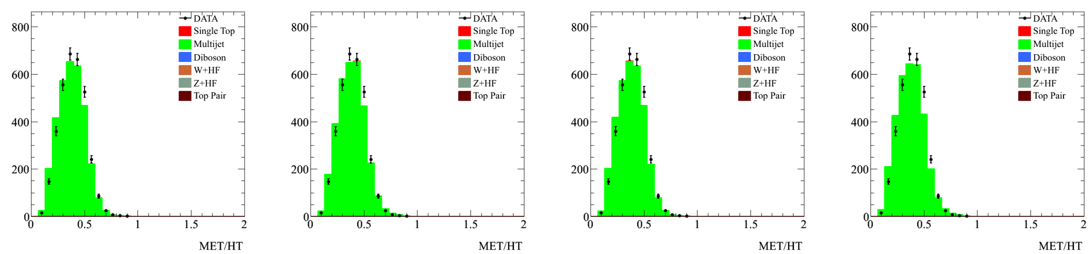


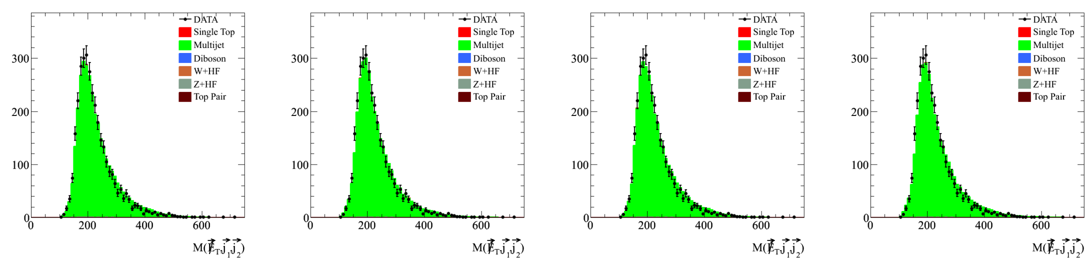

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

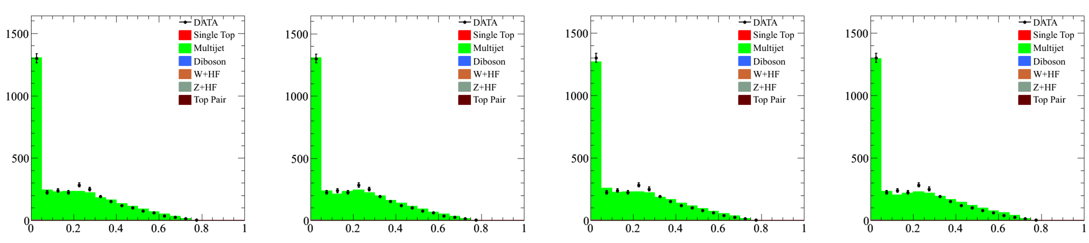

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET

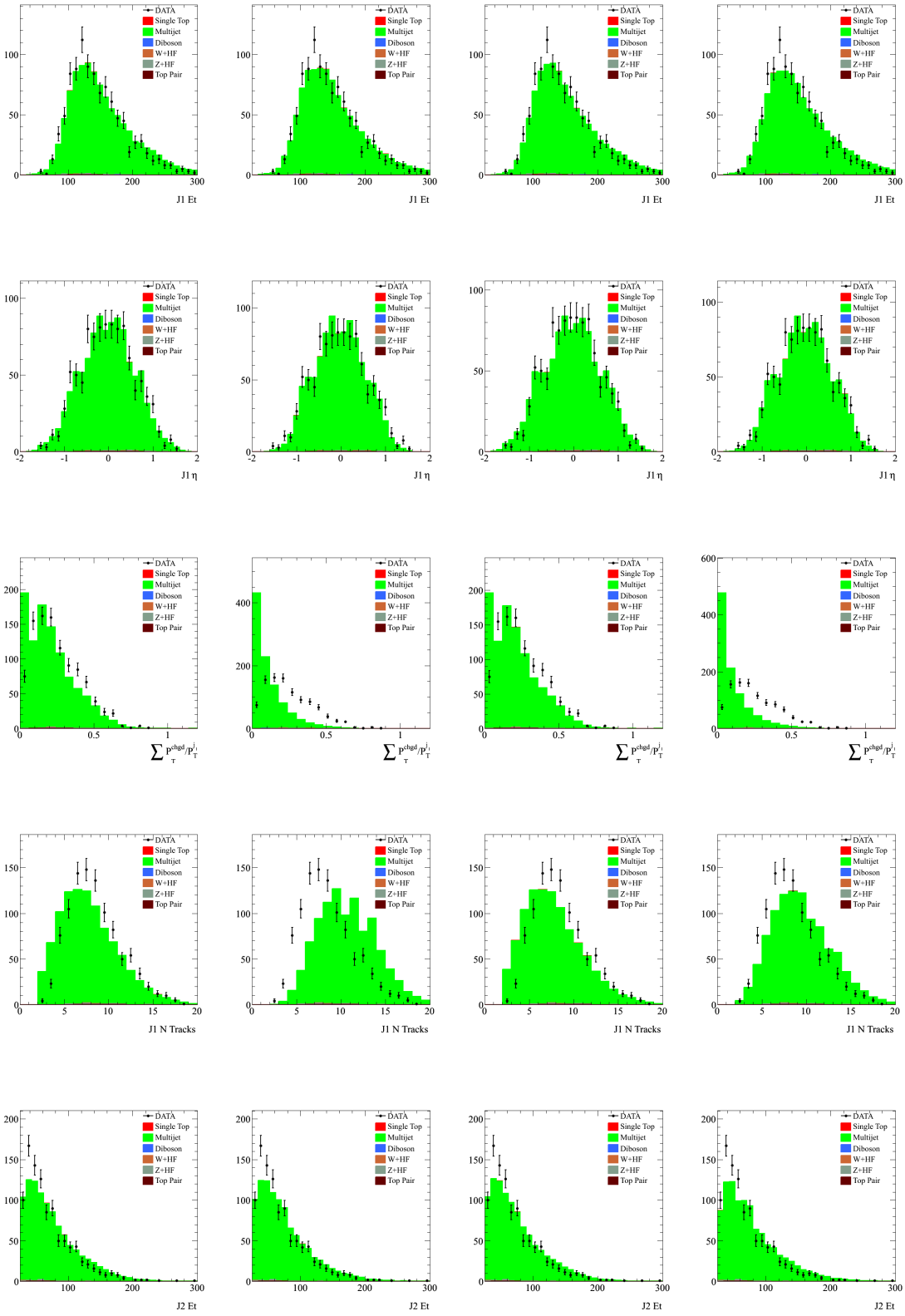

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Δϕ (leading jets in two-jet RF, boost)

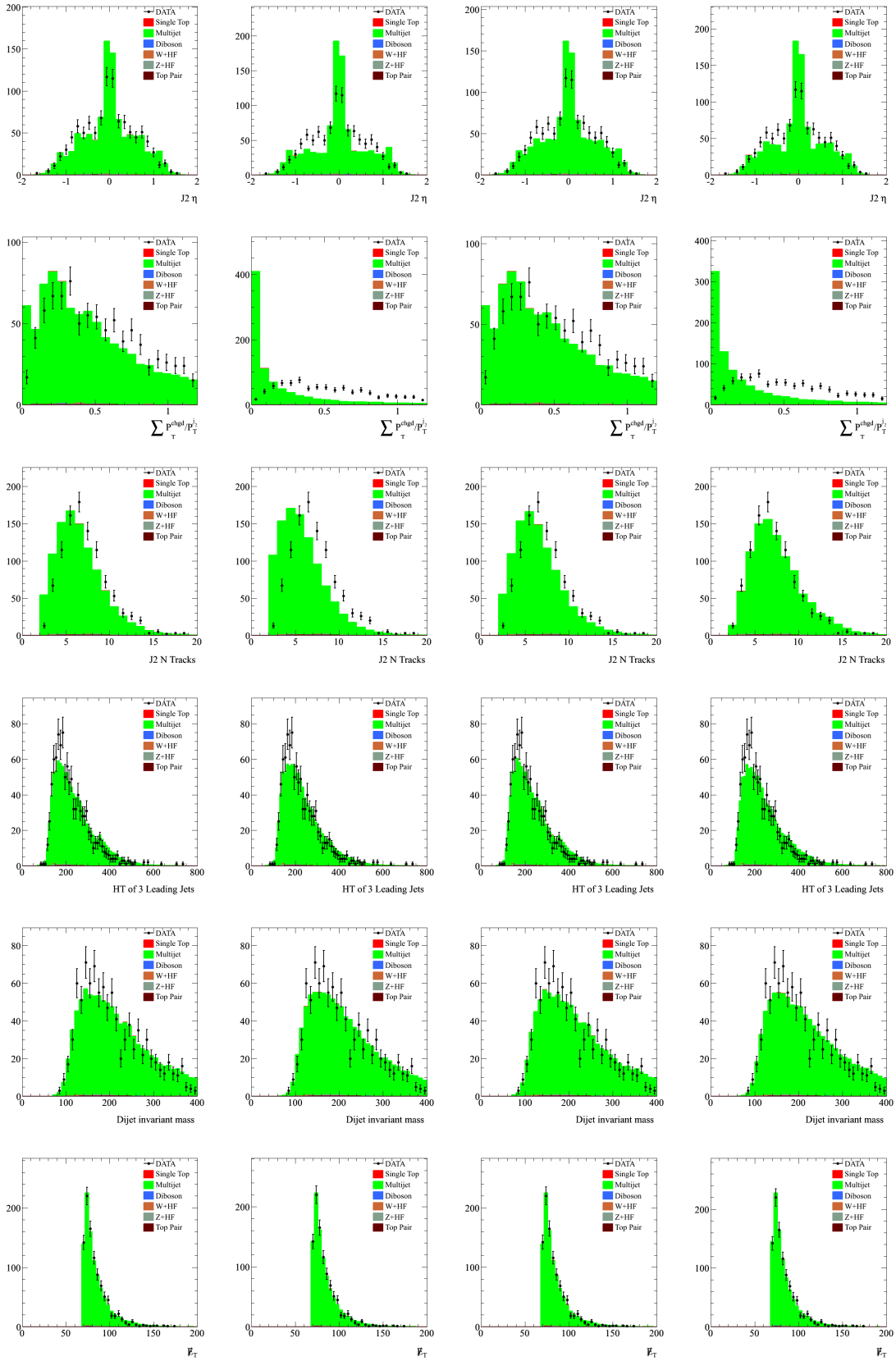

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MET/HT

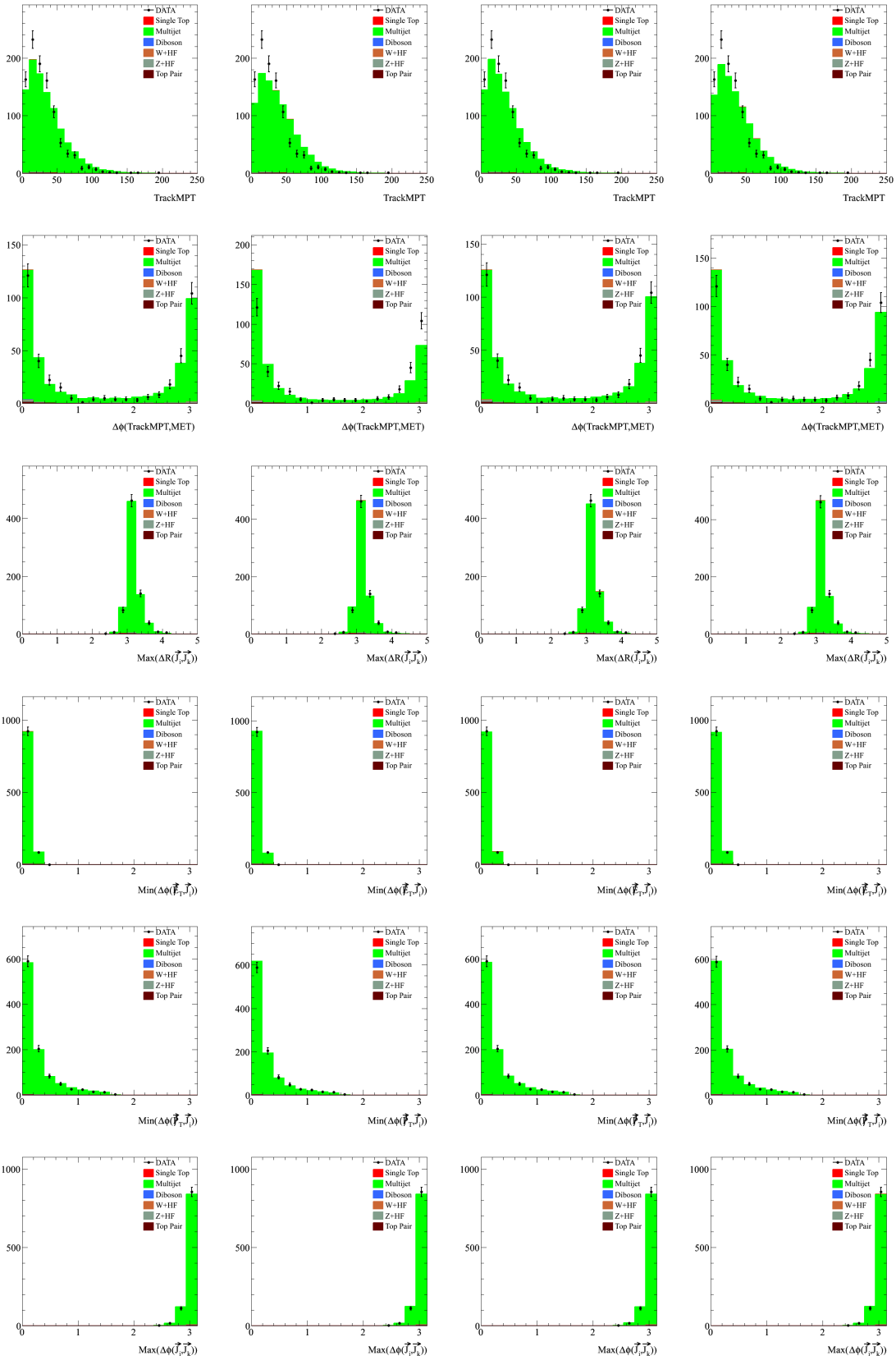

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
M($\vec{\not{E}}_T\vec{j}_1\vec{j}_2$)

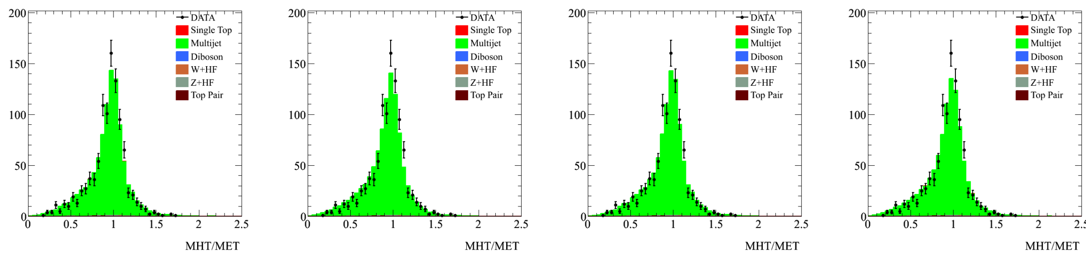

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Sphericity

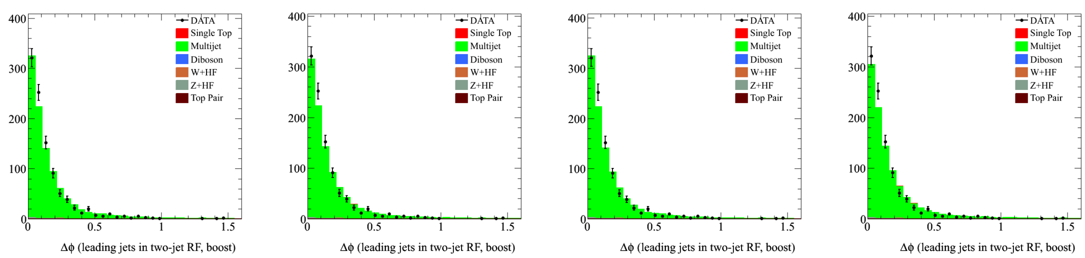
2.3.2 QCDCR/ region

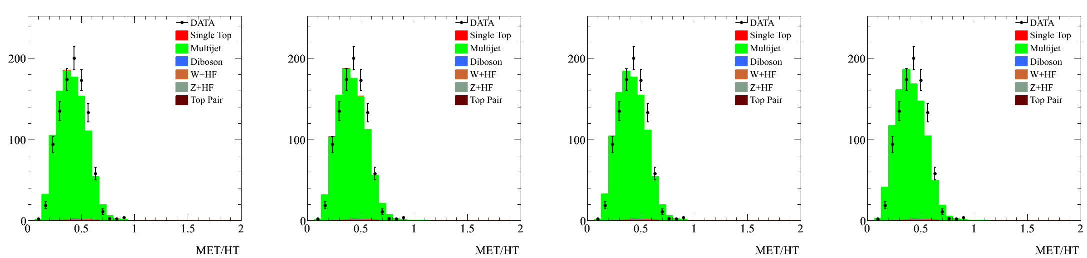


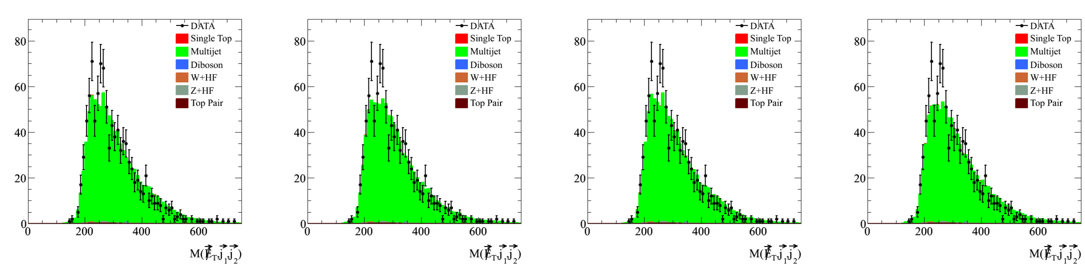

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_\tau^{chgd}/p_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$

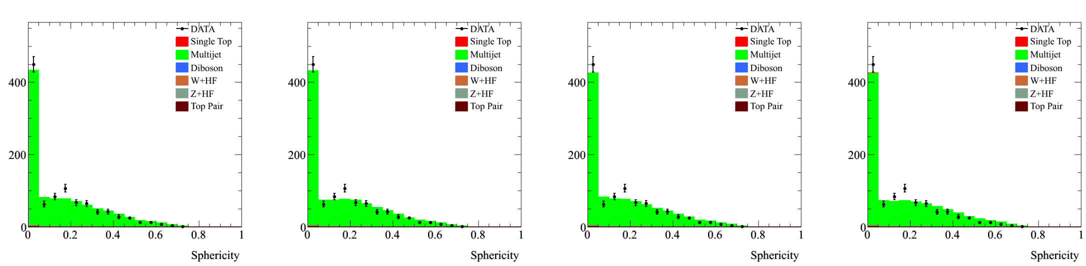

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET

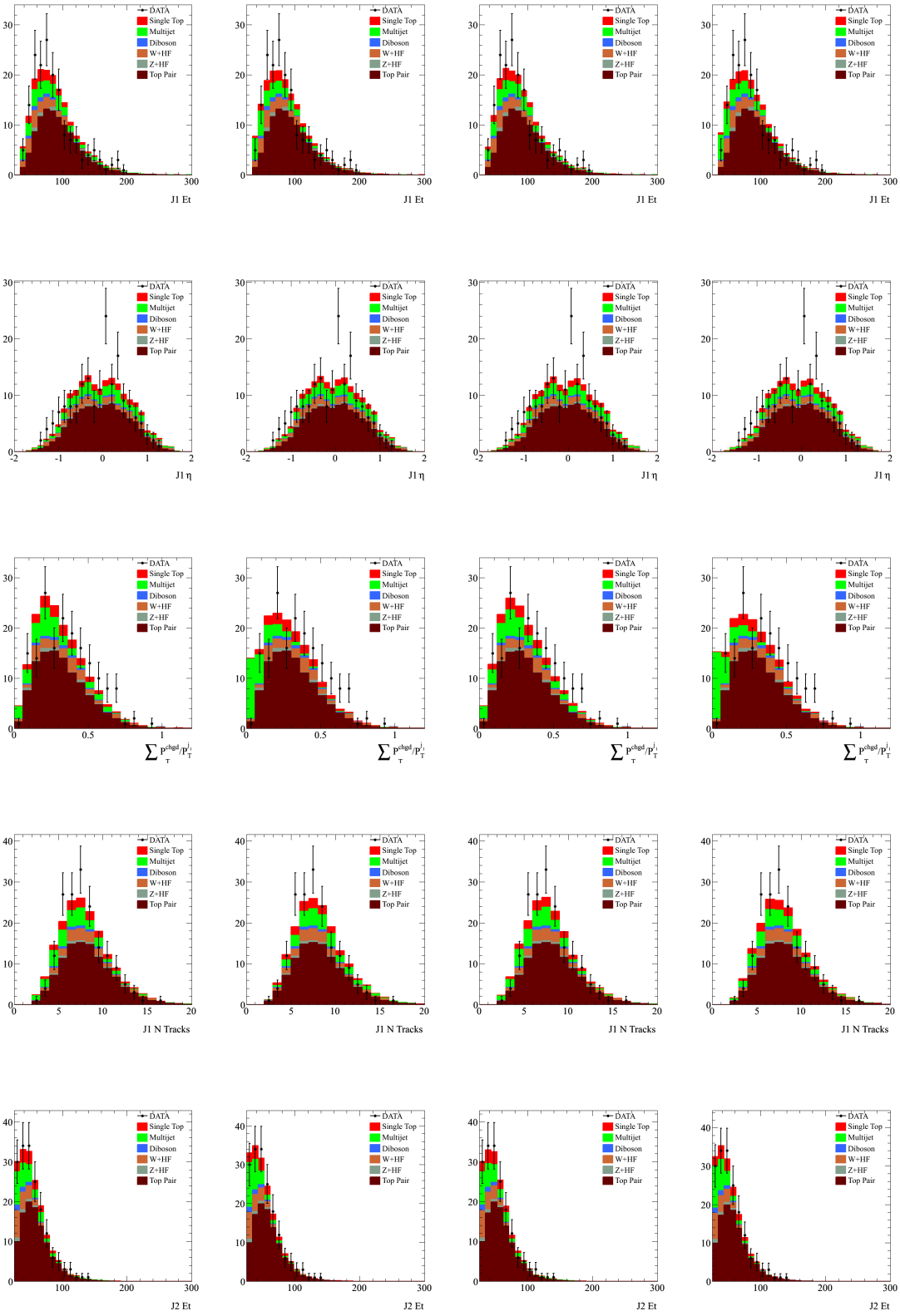

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Δϕ (leading jets in two-jet RF, boost)

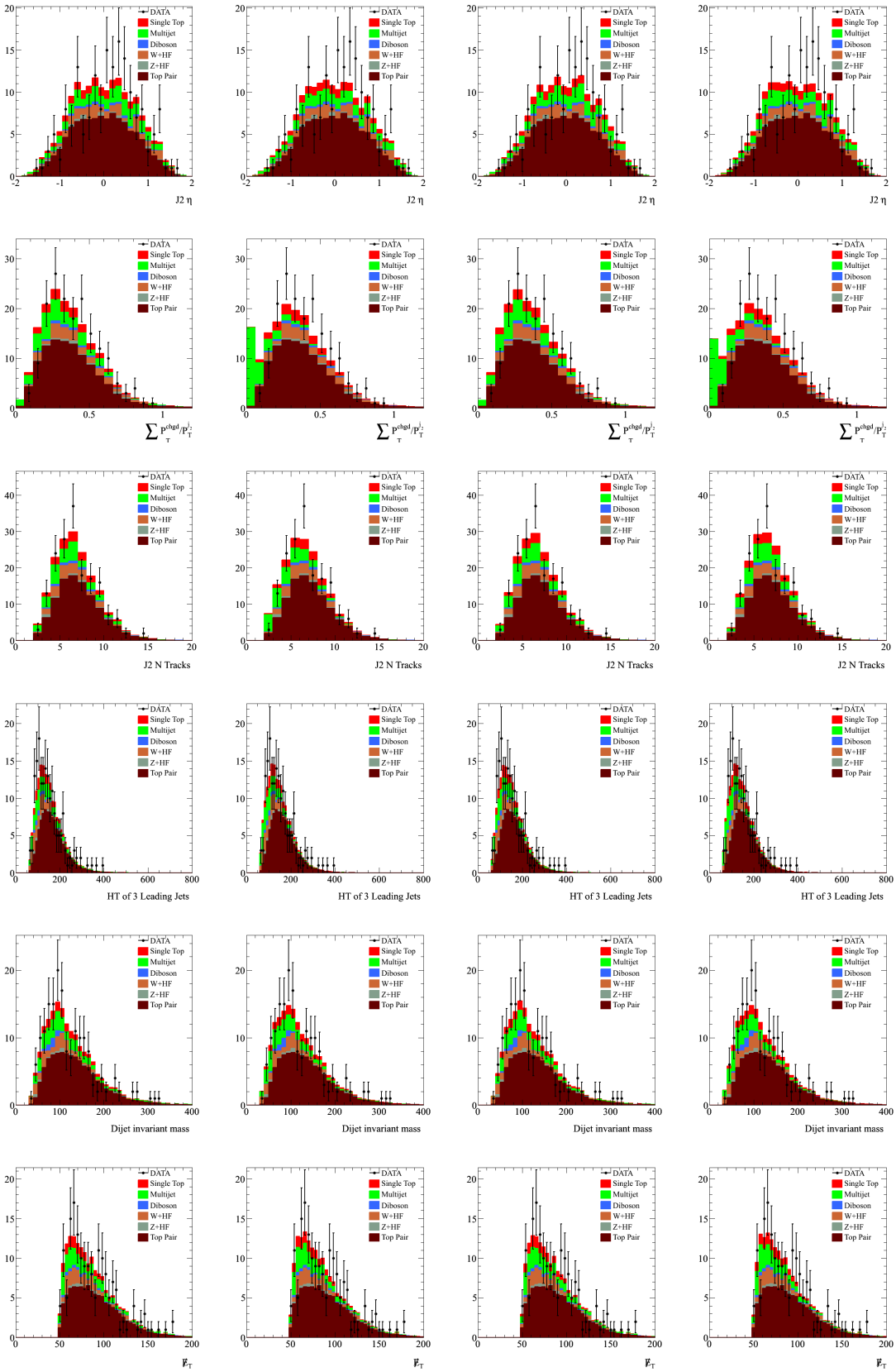

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MET/HT

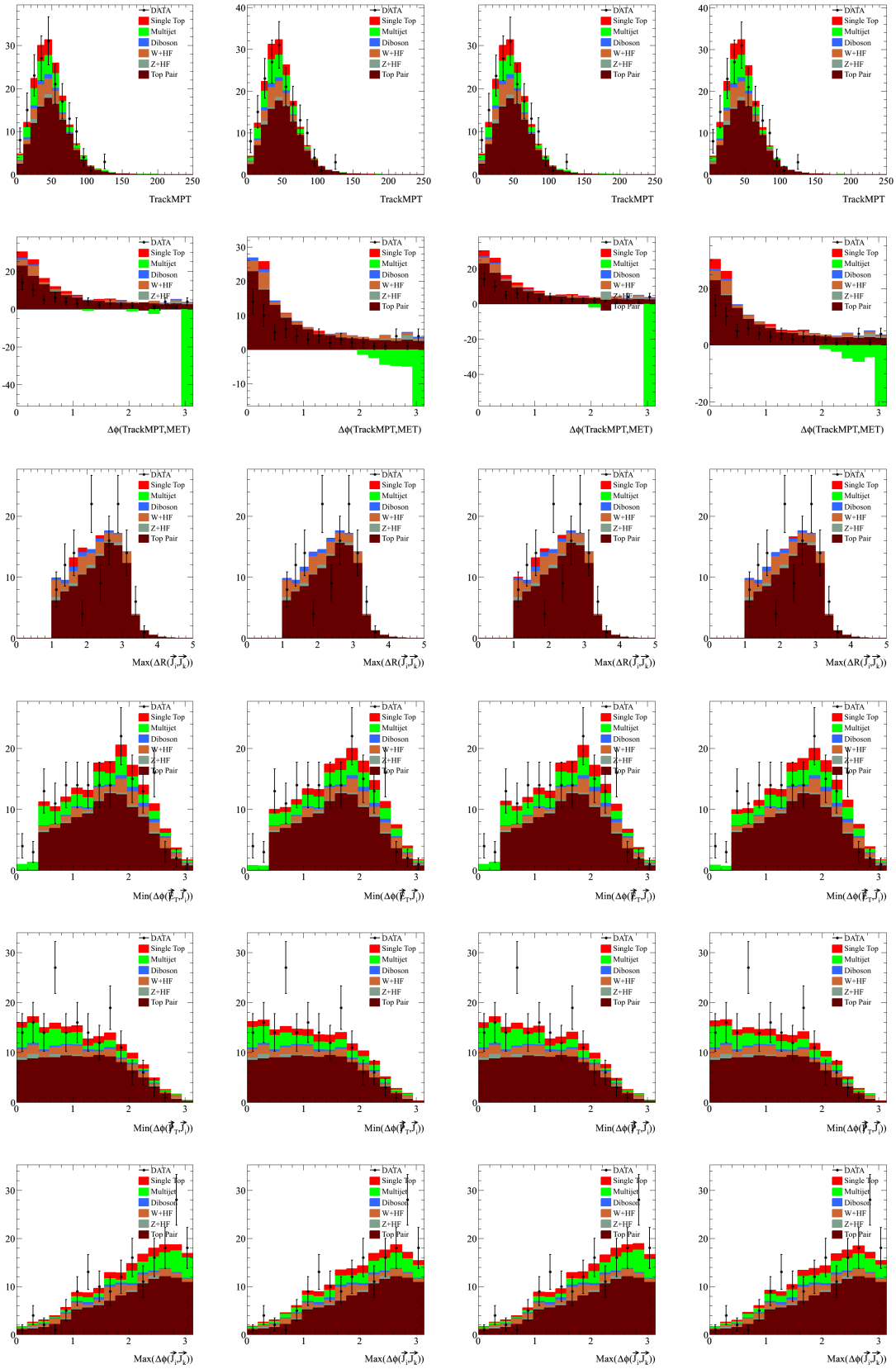

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair

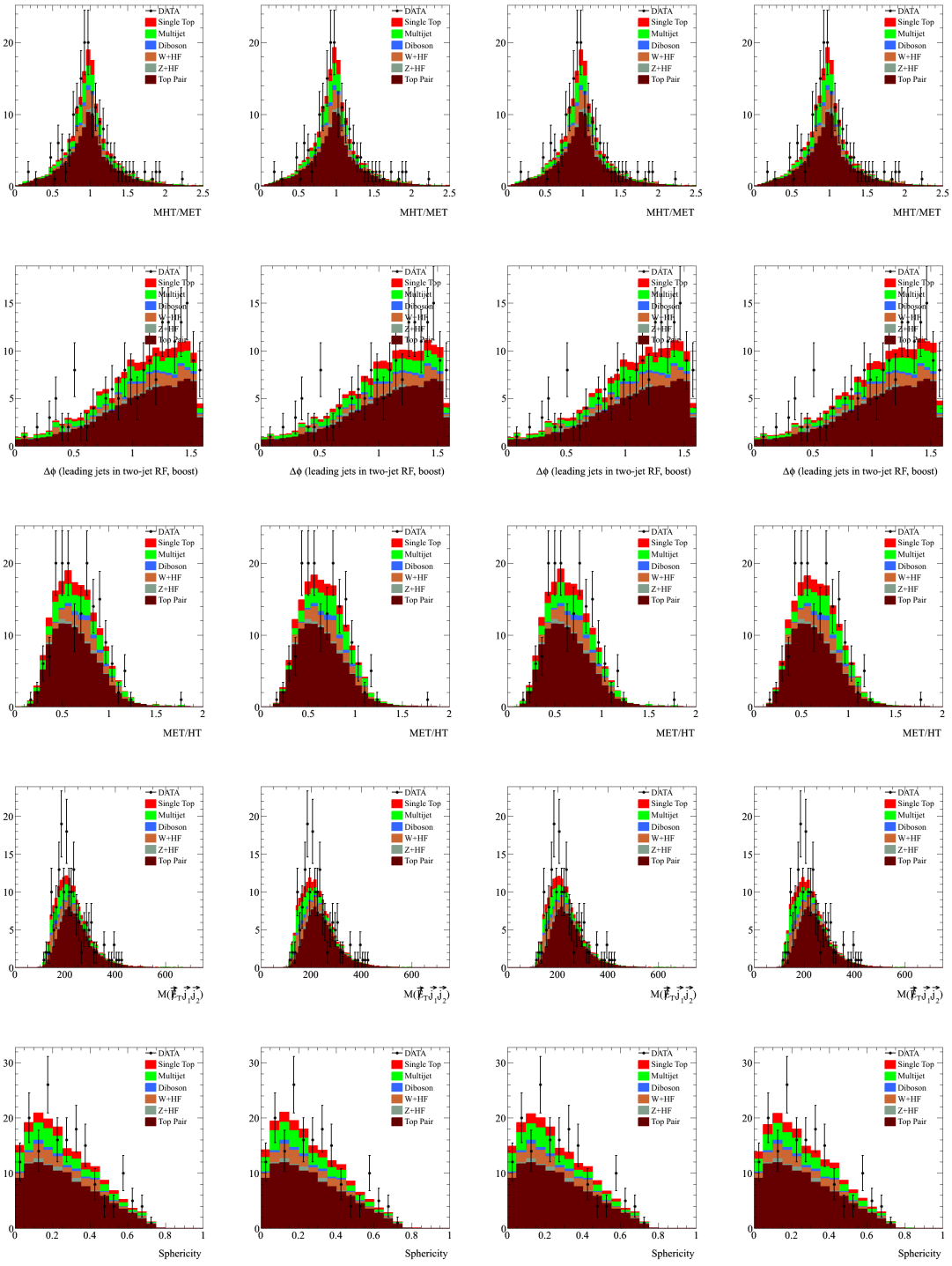

DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
Sphericity

2.3.3 EwkCR/ region




DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
J2 η
$\sum P_T^{chgd}/P_T^2$
J2 N Tracks
HT of 3 Leading Jets
Dijet invariant mass
$\not{E}_T$


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
TrackMPT
Δφ(TrackMPT,MET)
Max(ΔR(J_i,J_k))
Min(Δφ(P_T,J_i))
Max(Δφ(J_i,J_k))


DATA
Single Top
Multijet
Diboson
W+HF
Z+HF
Top Pair
MHT/MET
Δϕ (leading jets in two-jet RF, boost)
MET/HT
Sphericity

2.4 Summary on these "new" approaches

- Try2 delivers the worst predictions, this indicates J1(2)Ntrk is much less powerful than J1(2)Z.
- From try3, we can see that the J1(2)ϕ works similar as J1(2) $|\eta|$. Their role is more like splitting matrix, which I mean the tagging rate dependence on these two parameter is not big.
- From try4, with 5 parameters, it delivers a decent prediction, but the less powerful J1(2)Ntrk still shows a worse prediction.